




FC-20-006

Revision 0

Fort Calhoun Station Building End State Concrete Surface Areas and Volumes

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FCS Bldg End State Concrete Surface Areas & Volumes

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1.0 ISSUE STATEMENT

The primary purpose of this paper is to provide bounding and conservative estimates of the concrete surface areas, volumes and void spaces in the Fort Calhoun Station Building basements that will remain as part of the end state during License Termination. The Fort Calhoun License Termination Plan (LTP) states that structures will be removed to 3 feet below grade. These estimates are for the basements of the structures that are greater than 3 feet below grade.

2.0 BACKGROUND STATEMENT

The Fort Calhoun LTP states that structures will be removed to 3 feet below grade. Grade level is the 1004 foot elevation at the site. Therefore, basement structures below the 1001 foot elevation will remain as part of the end state and will require characterization and survey in order to meet the 10 CFR 20 Subpart E release criteria. The impacted end state structures below grade consist of the Turbine Building, Containment, Auxiliary Building, Intake Structure, and Circ Water Tunnels.

3.0 METHODOLOGY

This calculation report was prepared in accordance with procedure RP-1010 Rev. 0. Each structure was analyzed for concrete surface area, void space, and concrete volume. The values for simple shapes were determined with an Excel spreadsheet as presented within this paper. More complex shapes were modeled in AutoCAD, from which data was incorporated into the same spreadsheets to determine the totals for each structure. In order to be bounding and conservative, the concrete volume of piers and other deep foundations are not included. This would further dilute the remaining source term and resulting concentrations for alternate scenarios evaluated. Any rounding or estimating was performed in a conservative manner to assume more surface area, void space, or concrete volume rather than less.

4.0 ASSUMPTIONS

The surface areas of the tops of the walls at the 1001' elevation have not been included in the surface area calculations. In addition, only the exposed interior surface areas are calculated. The exterior surface areas surrounded by soil, including the tops of the walls, are not likely to be contaminated. Therefore, only interior surface areas are calculated in this document. Any further assumptions unique to a structure are included in the corresponding section of the calculation. This report and all assumptions are to be reviewed before, during, and after decommissioning to ensure it reflects the actual end state of the project.

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5.0 CONCLUSIONS

The calculation results are summarized in the table below. These are overall values for each structure.

Structure	Concrete Surface Area (Total)		Void Space		Concrete Volume (Total)		Min. Wall Thickness
	ft ²	m ²	ft ³	m ³	ft ³	m ³	in
Aux Building	57,609	5,352	513,617	14,544	311,626	8,824	24
Containment	25,410	2,361	128,249	3,632	184,092	5,213	54.5
Turbine Building	43,192	4,013	280,531	7,944	165,676	4,691	24
Circ Water Tunnels	32,519	3,021	101,900	2,885	91,793	2,599	24
Intake Structure	23,125	2,235	177,560	5,028	79,571	2,253	24
TOTAL	182,785	16,981	1,201,857	34,033	832,757	23,581	-----

To aid in radiation modeling, the overall values were further broken down to present the concrete surface area and volume for only the floors and foundations of each structure. The inside perimeter length for the outer structure walls are also presented as linear footage.

Structure	Concrete Surface Area (Floors & Fdns Only)		Concrete Volume (Floors & Fdns Only)		Linear Footage	
	ft ²	m ²	ft ³	m ³	ft	m
Aux Building	33,737	3,134	255,679	7,240	1,719	524
Containment	8,475	787	140,632	3,982	1,171	357
Turbine Building	24,948	2,318	131,720	3,730	1,328	405
Circ Water Tunnels	----	----	----	----	1,382	421
Intake Structure	6,369	592	51,084	1,447	306	93
TOTAL	73,529	6,831	579,115	16,399	5,907	1,800

6.0 CALCULATIONS

6.1 Aux Building

6.1.1 Assumptions

- The top of the spent fuel pit foundation is at EL 995'-6". It is assumed that the surrounding walls are cut such that the base of the walls are at the same EL 995'-6".
- All interior walls will be removed UNO.
- The floor above the sub-basement at EL 971'-0" will be removed to expose the entire sub-basement.
- Any deep footings are excluded from the concrete volume total.

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- E. This section includes all items up to, but not including, the Containment exterior wall. For calculation simplicity, this includes an imaginary line in the foundation, rather than the existing construction joints.
- F. The Containment concrete curb volume is included in the volume total for floors and foundations.

6.1.2 Drawings Referenced

Item #	Drawing #	Rev.	OPPD Doc. #	Rev.	Item #	Drawing #	Rev.	OPPD Doc. #	Rev.
1	11405-S-48	7	16433	2	8	11405-S-63	9	16448	15
2	11405-S-50	18	16435	18	9	11405-S-64	8	16449	11
3	11405-S-51	18	16436	18	10	11405-S-68	6	16453	8
4	11405-S-59	9	16444	3	11	11405-S-77	7	16461	---
5	11405-S-60	7	16445	---	12	11405-S-78	8	16462	---
6	11405-S-61	7	16446	14	13	11405-S-79	5	16463	---
7	11405-S-47	7	16432	15					

6.1.3 Concrete Surface Area

Sub basement EL 971'-0" to EL 989'-0":

Floor area:	6,333.76	ft ²	<i>AutoCAD Figure 1</i>
Wall perimeter:	349.20	ft	<i>AutoCAD Figure 4</i>
Wall depth:	18.00	ft	<i>EL 971' to 989'</i>
Wall area:	6,285.60	ft ²	
Total area:	12,619.36	ft ²	

Basement @ EL 989'-0" inside walls:

Tot floor area:	25,108.90	ft ²	<i>Up to containment curb</i>
Outer wall perimeter:	888.28	ft	<i>Not including Containment wall</i>
Wall depth:	12.00	ft	<i>EL 989' to 1001'</i>
Wall area:	10,659.36	ft ²	
Total surface area:	35,768.26	ft ²	

Spent fuel pit @ EL 995'-6":

Floor area:	1,823.56	ft ²	<i>AutoCAD Figure 1; assumes walls are cut to EL 995'-6"</i>
Total perimeter:	201.25	ft	<i>from AutoCAD</i>
Wall height:	6.50	ft	<i>EL 989' to 995'-6"</i>
Wall area:	1,308.13	ft ²	
Total surface area:	3,131.69	ft ²	

Containment outer wall:

Arc length:	244.85	ft	<i>from AutoCAD</i>
Height:	10.00	ft	<i>top of curb (EL 991') to EL 1001'</i>
Surface Area:	2,448.50	ft ²	

FCS Bldg End State Concrete Surface Areas & Volumes

Curb around Containment:

Exposed face length:	3.71	ft	
Arc length:	245.22	ft	<i>AutoCAD Figure 1</i>
Surface area:	909.77	ft ²	

Annulus:

Floor area:	471.26	ft ²	<i>AutoCAD Figure 1</i>
Room perimeter:	226.00	ft	
Wall height:	10.00	ft	<i>EL 991' to EL 1001'</i>
Wall surface area:	2,260.00	ft ²	
Total surface area:	2,731.26	ft ²	

Linear footage:

Basement & Annulus:	998.13	ft	<i>AutocCAD Figure 29</i>
Sub basement:	349.20	ft	<i>AutocCAD Figure 29</i>
Countainment wall:	371.66	ft	<i>AutocCAD Figure 29</i>

LINEAR FOOTAGE:	1,719	ft
FLOOR/FDN SURFACE AREA:	33,737	ft²
TOTAL OVERALL SURFACE AREA:	57,609	ft²

6.1.4 Void Space

Sub basement EL 971'-0" to EL 989'-0"

Floor area:	6,333.76	ft ²	<i>AutoCAD Figure 1</i>
Void depth:	30.00	ft	<i>EL 971' to 1001'</i>
Void volume:	190,012.80	ft ³	

Basement @ EL 989'-0" inside walls:

Tot floor area:	25,108.90	ft ²	<i>Up to Containment curb</i>
Void depth:	12.00	ft	<i>EL 989' to 1001'</i>
Void volume:	301,306.80	ft ³	

Spent fuel pit @ EL 995'-6":

Floor area:	1,823.56	ft ²	<i>AutoCAD Figure 1; walls cut to EL 995'-6"</i>
Void depth:	5.50	ft	<i>EL 995'-6" to 1001'</i>
Void volume:	10,029.58	ft ³	

Above Containment curb:

Curb cross section area:	3.75	ft ²	
Curb width:	2.88	ft	
Void height:	12.00	ft	<i>EL 989' to 1001'</i>

FCS Bldg End State Concrete Surface Areas & Volumes

Net void area:	30.81	ft ³	<i>Curb width x void height - curb area</i>
Arc length:	245.22	ft	
Net void volume:	7,555.23	ft ³	<i>Net void area x arc length</i>

Annulus:

Floor area:	471.26	ft ²	<i>AutoCAD Figure 1</i>
Void height:	10.00	ft	<i>EL 991' to EL 1001'</i>
Void volume:	4,712.60	ft ³	

TOTAL VOID SPACE:	513,617	ft³
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6.1.5 Concrete Volume

Sub basement @ EL 971'-0"

Fdn area =	7,488.58	ft ²	<i>AutoCAD Figure 4</i>
Fdn thickness =	5.50	ft	
Fdn conc. volume =	41,187.19	ft ³	

Curved wall:	Cross section area =	235.54	ft ²	<i>AutoCAD Figure 4</i>
	Wall height =	8.00	ft	<i>from EL 971' to 979'</i>
	Wall conc. volume =	1,884.32	ft ³	

Remaining walls:	Cross section area =	919.28	ft ²	<i>AutoCAD Figure 4</i>
	Wall height =	12.50	ft	<i>from EL 971' to 983'-6"</i>
	Wall conc. volume =	11,491.00	ft ³	

Total concrete volume =	54,562.51	ft³
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Basement @ EL 989'-0" inside walls:

Cut section area =	2,203.82	ft ²	<i>AutoCAD Figure 3</i>
Wall height =	12.00	ft	<i>from EL 989' to 1001'</i>
Concrete volume =	26,445.84	ft ³	

Annulus wall:

Straight portion:	Cut section area =	270.95	ft ²	<i>AutoCAD Figure 3</i>
	Wall height =	10.00	ft	<i>from EL 991' to 1001'</i>
	Concrete volume =	2,709.50	ft ³	

Angled portion:	Cut section area =	7.29	ft ²	<i>AutoCAD Figure 5</i>
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FCS Bldg End State Concrete Surface Areas & Volumes

Arc length = 88.26 ft *from AutoCAD*
 Concrete volume = 643.42 ft³

Total concrete volume = **3,352.92 ft³**

Spent fuel pit @ EL 995'-6":

Cut section area = 1,823.56 ft² *AutoCAD Figure 3*
 Depth = 6.50 ft *EL 989' to 995'-6"*
 Concrete volume = **11,853.14 ft³**

Containment curb:

Cross section area = 3.75 ft²
 Arc length = 245.22 ft
 Concrete volume = **919.58 ft³**

Foundation volumes (refer to Figure 2 for Area identification):

Area 1:	Thickness =	10.00 ft	<i>EL 979' to 989' (sloped)</i>
	Area =	700.00 ft ²	<i>AutoCAD Figure 2</i>
	Concrete volume =	7,000.00 ft ³	
	Halved for slope =	3,500.00 ft ³	
Area 2:	Thickness =	10.00 ft	<i>EL 979' to 989'</i>
	Area =	6,301.00 ft ²	<i>AutoCAD Figure 2</i>
	Concrete volume =	63,010.00 ft ³	
Area 3:	Thickness =	12.00 ft	<i>EL 979' to 991'</i>
	Area =	1,691.00 ft ²	<i>AutoCAD Figure 2</i>
	Concrete volume =	20,292.00 ft ³	
Area 4:	Thickness =	10.00 ft	<i>EL 979' to 989' (sloped)</i>
	Area =	403.00 ft ²	<i>AutoCAD Figure 2</i>
	Concrete volume =	4,030.00 ft ³	
	Halved for slope =	2,015.00 ft ³	
Area 5:	Thickness =	5.50 ft	<i>EL 983'-6" to 989'</i>
	Area =	22,850.00 ft ²	<i>AutoCAD Figure 2</i>
	Concrete volume =	125,675.00 ft ³	

Total concrete volume = **214,492.00 ft³**

FLOOR/FDN CONCRETE VOLUME: **255,679 ft³**

TOTAL CONCRETE VOLUME: **311,626 ft³**

Includes curbs

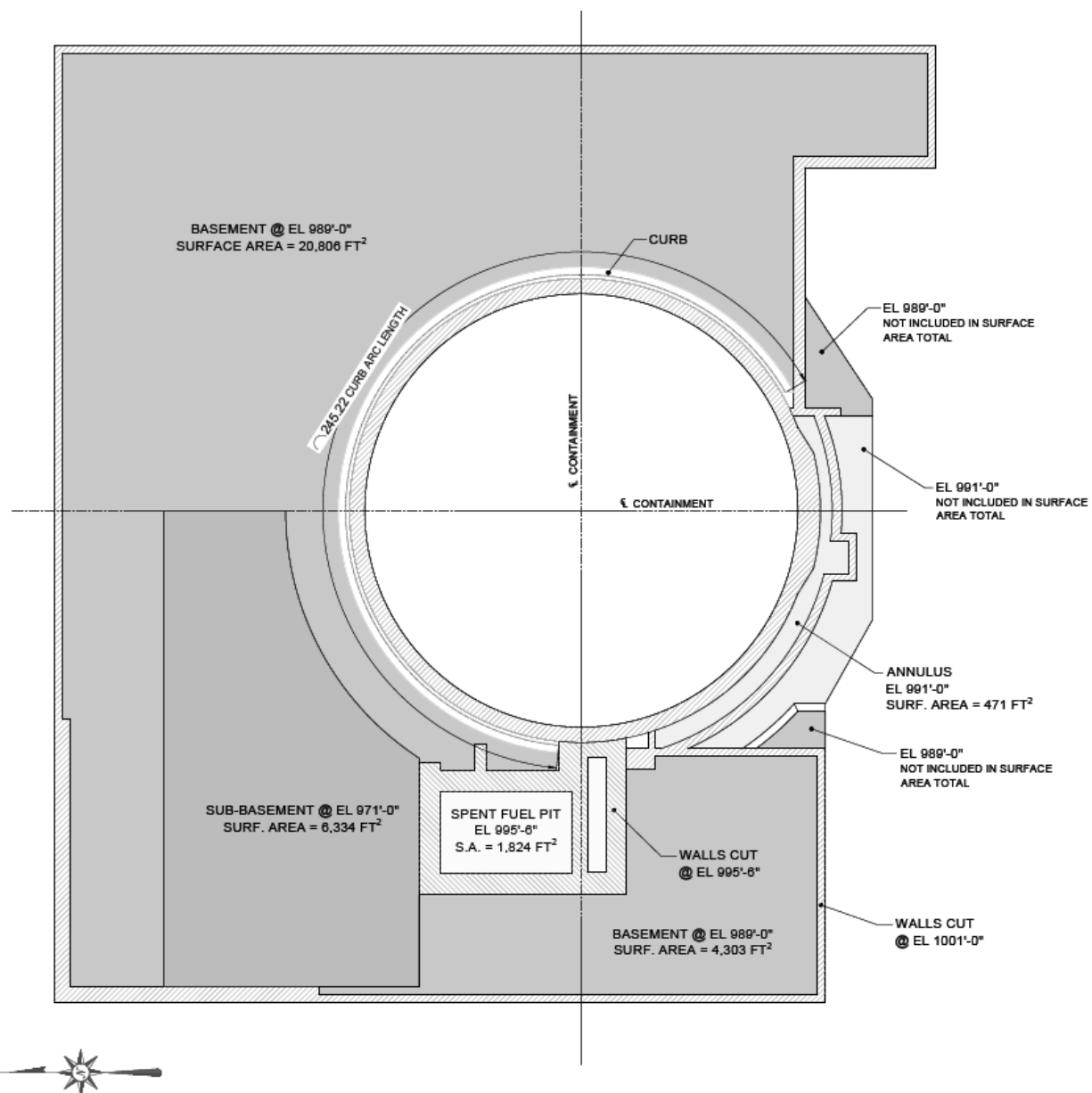


Figure 1 – Aux Building Floor Elevations and Surface Area

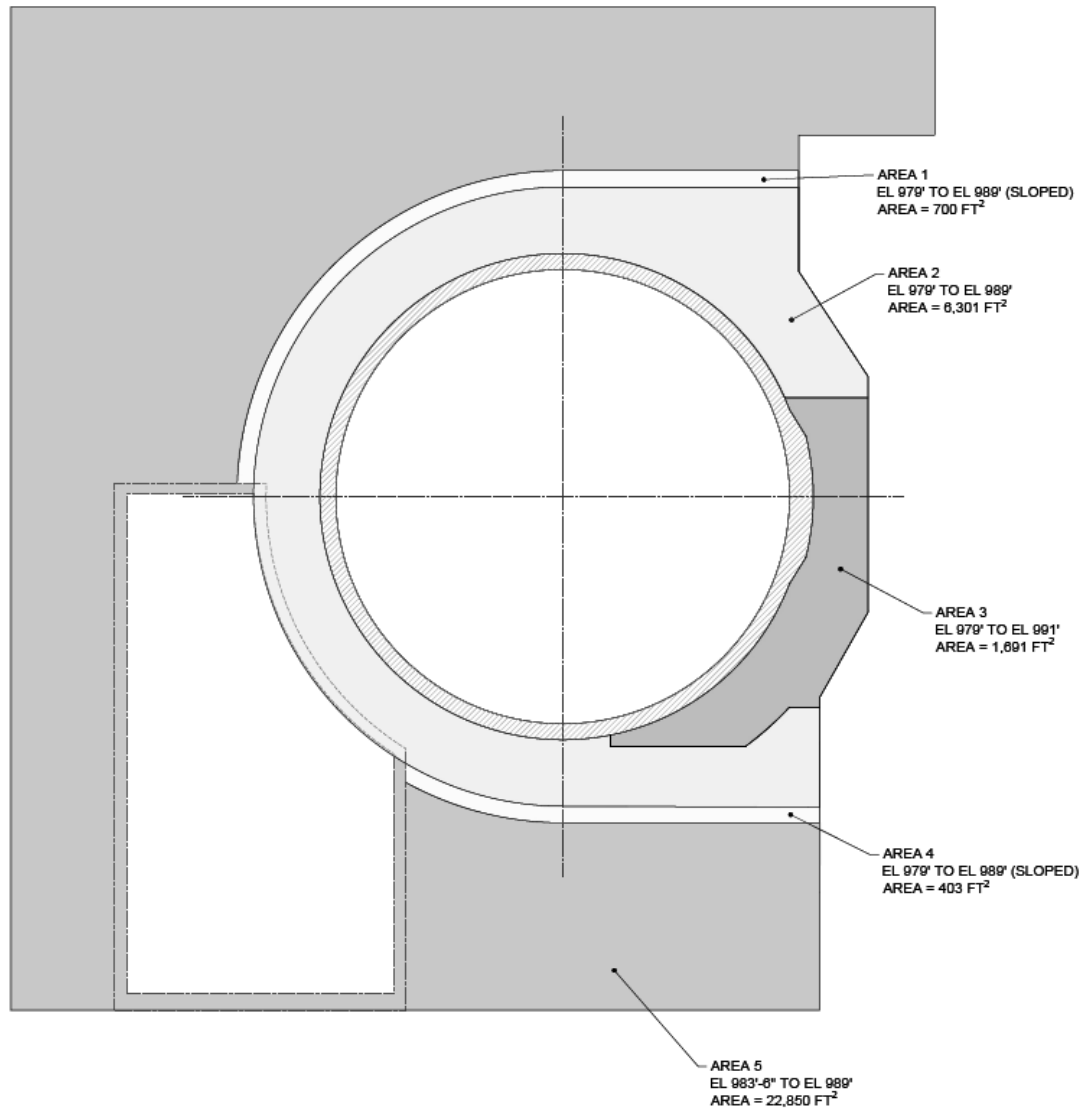


Figure 2 – Aux Building Foundations

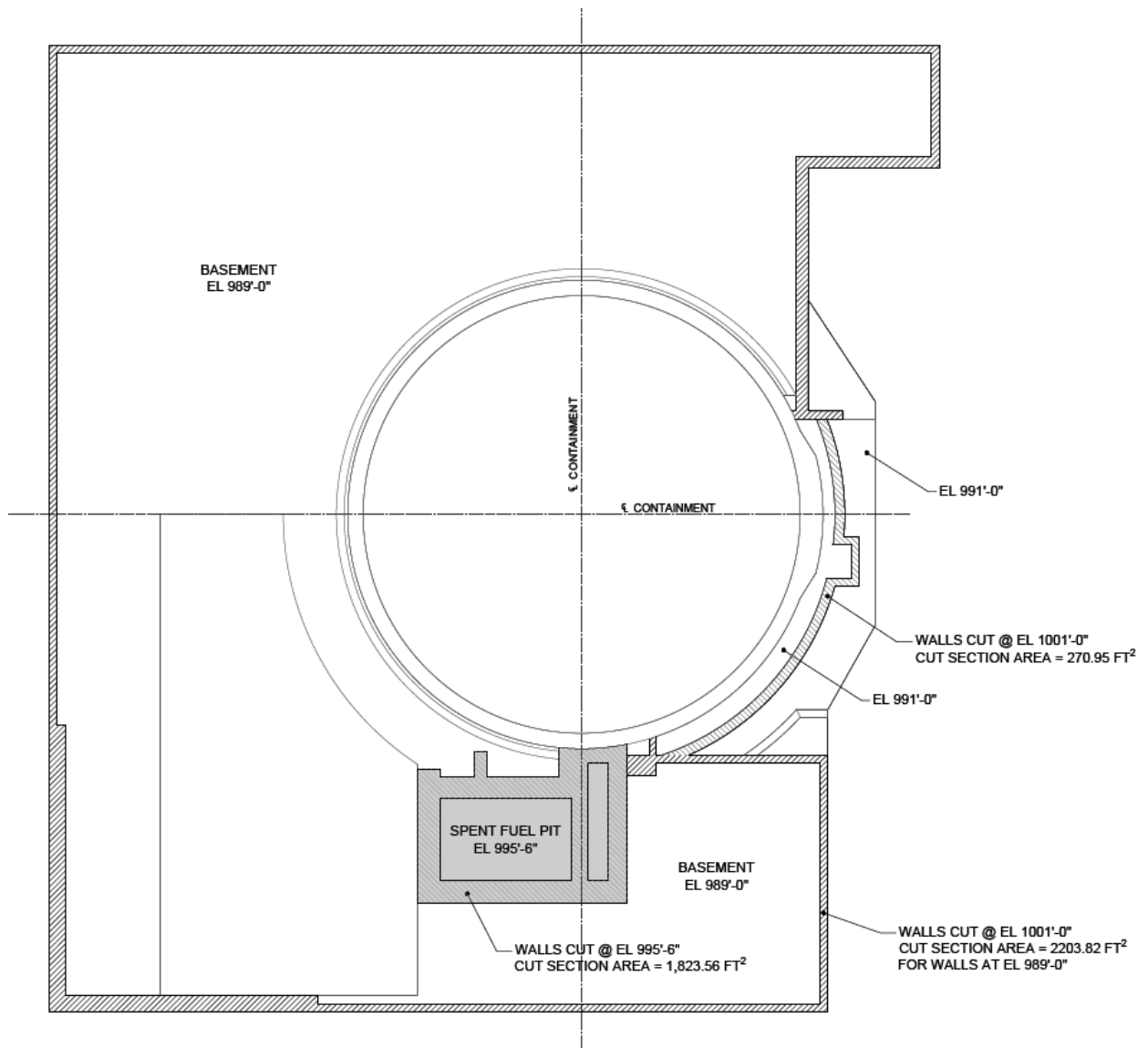


Figure 3 – Aux Building Cut Section Areas

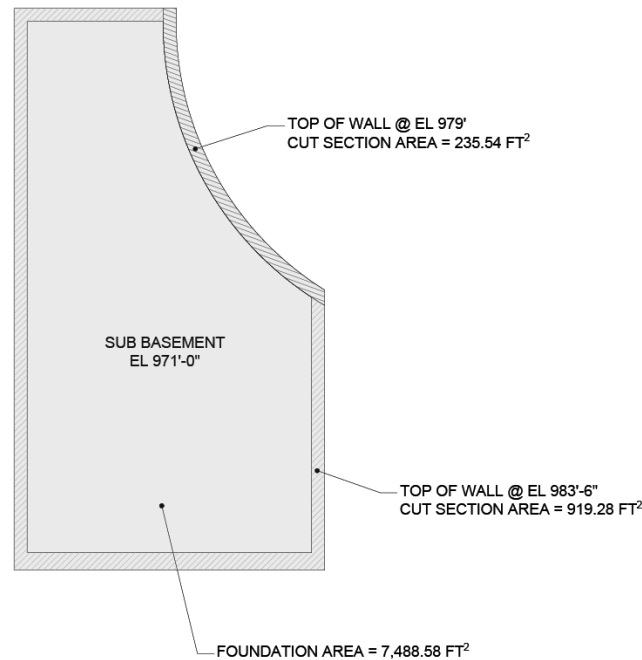


Figure 4 – Sub-basement Wall and Foundation Areas

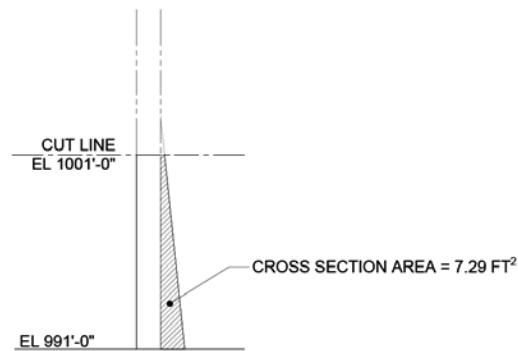


Figure 5 – Sloped Section of Annulus Outer Wall

6.2 Containment

6.2.1 Assumptions

- A. All interior walls will be removed UNO.
- B. For calculation simplicity, the foundation is only considered up to imaginary line of outer Containment wall rather than existing Construction joints. Foundations beyond that are captured in the Aux Building calculation.

- C. The stressing gallery is included in the overall surface area and concrete volume totals, but is excluded from the totals specific to floors and foundations only.
- D. The stressing gallery is omitted from the minimum wall thickness determination as it is at a low elevation and is a relatively insignificant structure compared to the rest of Containment.

6.2.2 Drawings Referenced

Item #	Drawing No.	Rev.	OPPD Doc. No.	Rev.
1	11405-S-17	7	16396	17
2	11405-S-23	4	16402	5
3	11405-S-24	4	16403	---
4	11405-S-6	9	16385	9
5	11405-S-8	7	16387	---
6	11405-S-14	8	16393	---
7	11405-S-15	6	16394	---
8	11405-S-16	6	16395	---

6.2.3 Concrete Surface Area

Containment shell inner walls:

Upper slope length =	8.83	ft	
Dist to CL =	53.77	ft	<i>AutoCAD Figure 9</i>
Surface area =	2,983.19	ft ²	<i>Length * πD</i>
Lower slope length =	1.77		
Dist to CL =	52.56	ft	<i>AutoCAD Figure 9</i>
Surface area =	584.53	ft ²	<i>Length * πD</i>
Total surface area =	3,567.72	ft²	<i>Upper + Lower</i>

Containment floor:

Diameter =	103.88	ft	
Surface area =	8,475.27	ft²	<i>Accounts for floors @ EL 991' & 973'-6"</i>

Containment foundation circular walls:

Diameter =	33.50	ft	
Circumference =	105.24	ft	<i>πD</i>
Wall height =	17.50	ft	<i>EL 973'-6" to 991'</i>
Surface area =	1,841.76	ft²	<i>Circumference x wall ht</i>

Stressing gallery:

Inside perimeter =	31.67	ft	<i>7' x 8'-10"</i>
Dist. center to CL Cont. =	57.92	ft	
Surface area =	11,524.78	ft²	<i>Perimeter x πD</i>

Linear footage:

Containment shell:

Dist to CL = 53.77 ft *AutoCAD Figure 9*

Linear footage = **337.85 ft** $2\pi R$

Stressing gallery outer wall:

Dist to CL = 61.42 ft *AutoCAD Figure 7*

Linear footage = **385.91 ft** $2\pi R$

Stressing gallery inner wall:

Dist to CL = 54.42 ft *AutoCAD Figure 7*

Linear footage = **341.93 ft** $2\pi R$

Containment fdn circular wall:

Diameter = 33.50 ft

Linear footage = **105.24 ft** πD

LINEAR FOOTAGE:	1,171 ft	
FLOOR/FDN SURFACE AREA:	8,475 ft²	<i>does not include stressing gallery</i>
TOTAL OVERALL SURFACE AREA:	25,410 ft²	

6.2.4 Void Space

Containment shell:

Cross section area = 536.20 ft² *AutoCAD Figure 9*

Dist. centroid to CL = 26.81 ft

Void volume = **90,324.28 ft³** $Area * \pi D$

Stressing gallery:

Cross section area = 61.83 ft² *7' x 8'-10"*

Dist. center to CL Cont. = 57.92 ft

Void volume = **22,500.02 ft³** $Area \times \pi D$

Containment
foundation:

Circular void diameter = 33.50 ft

Area = 881.41 ft²

Depth = 17.50 ft *EL 991' to 973'-6"*

Void volume = **15,424.73 ft³**

TOTAL VOID SPACE =	128,249 ft³
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6.2.5 Concrete Volume

Containment walls:

Straight portion:	Cut section area =	1,454.01	ft ²	<i>AutoCAD Figure 10</i>
	Wall height =	10.00	ft	<i>EL 991' to 1001'</i>
	Wall volume =	14,540.10	ft ³	

Angled base:	Cut section area =	14.01	ft ²	<i>AutoCAD Figure 8</i>
	Dist centroid to CL =	54.22	ft	
	Concrete volume =	4,772.85	ft ³	<i>Area x πD</i>

Total concrete volume =	19,312.95	ft³
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Stressing gallery:

	Cross section area =	50.00	ft ²	<i>10' x 10'-3" outside w/ 1.5' thick walls</i>
	Dist. center to CL Cont. =	57.92	ft	
	Concrete volume =	18,195.07	ft³	<i>Area x πD</i>

Containment foundation mat:

Circular bottom floor (10' thick):

	Diameter			
	r =	50.00	ft	
	Area =	1,963.50	ft ²	
	Thickness =	10.00	ft	<i>EL 963'-6" to 973'-6"</i>
	Concrete volume =	19,634.95	ft ³	

Circular walls EL 973'-6" to 979'-0"

	OD =	50.00	ft	
	ID =	33.50	ft	
	Cut section area =	1,082.08	ft ²	
	Wall height =	5.50	ft	
	Concrete volume =	5,951.44	ft ³	

Upper mat EL 979' to 991':

	Net			<i>AutoCAD plan view; accounts for</i>
	area =	10,083.12	ft ²	<i>penetration; within Containment walls</i>
	Depth =	12.00	ft	
	Concrete volume =	120,997.44	ft ³	

Total concrete volume =	146,583.83	ft³
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FLOOR/FDN CONCRETE VOLUME:	140,632	ft³
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does not include stressing gallery

TOTAL CONCRETE VOLUME =	184,092	ft³
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6.2.6 Figures

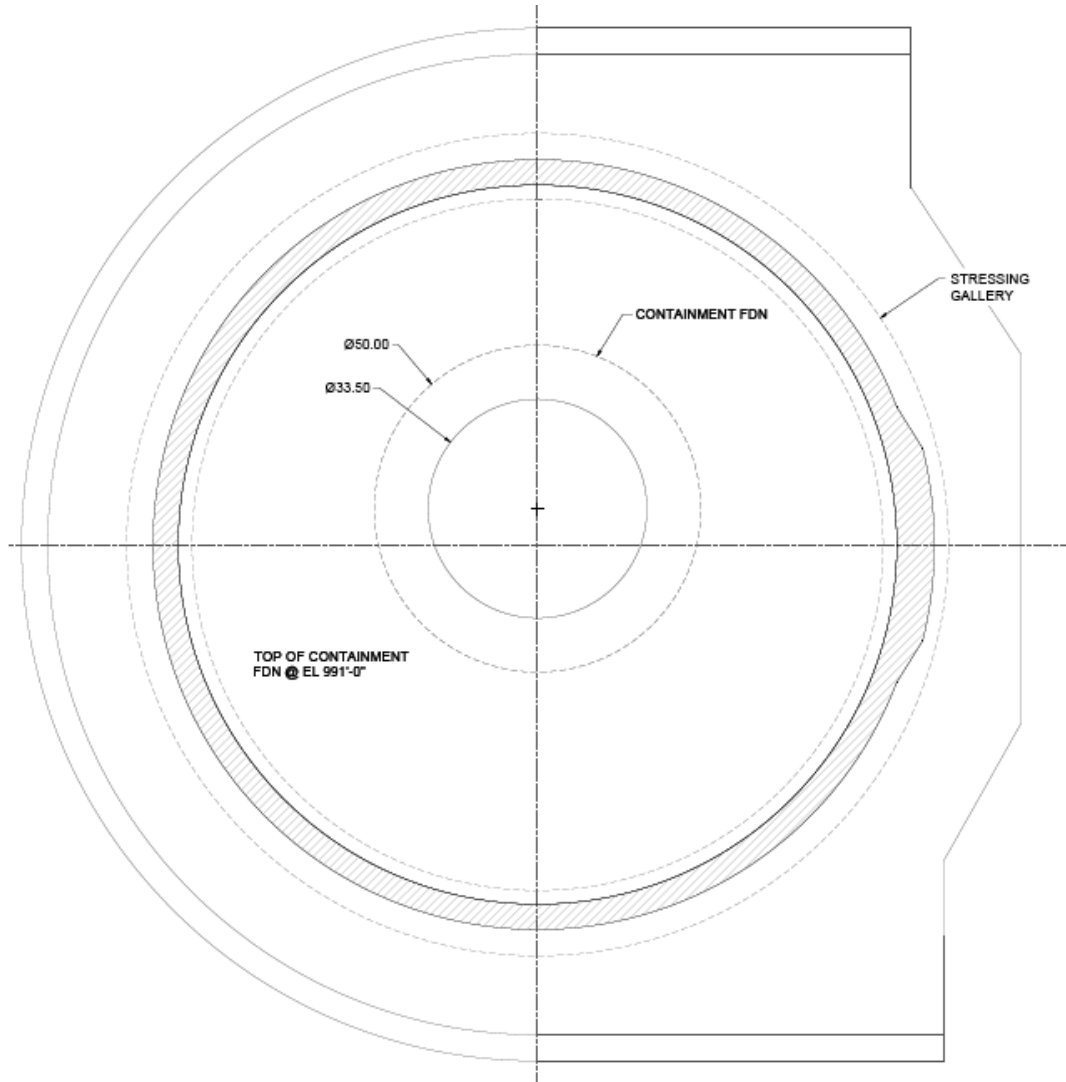


Figure 6 – Containment General Arrangement Plan View

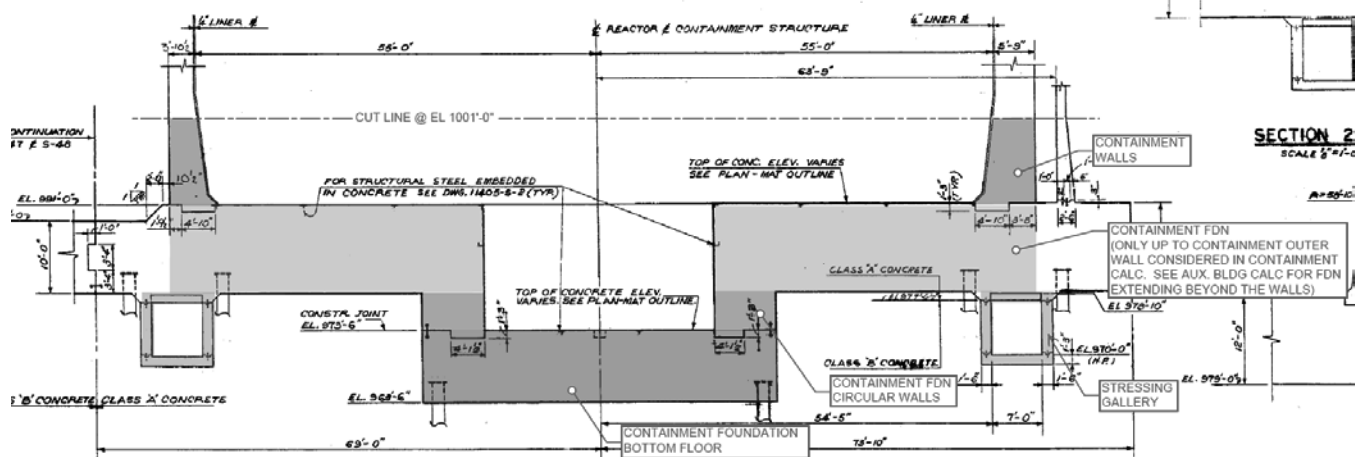


Figure 7 – Containment General Arrangement Elevation View

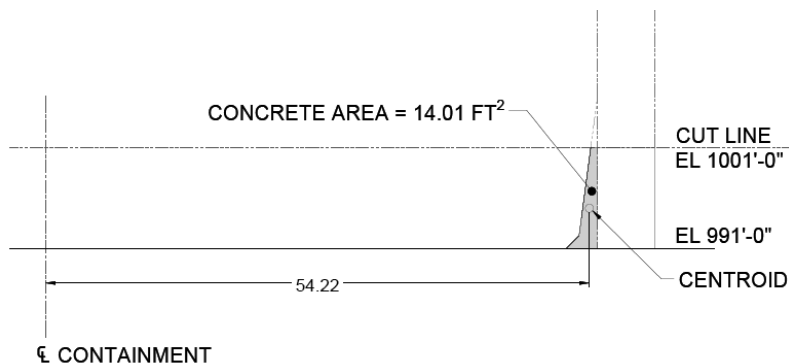


Figure 8 – Sloped Portion of Containment Walls Cross Sectional Area

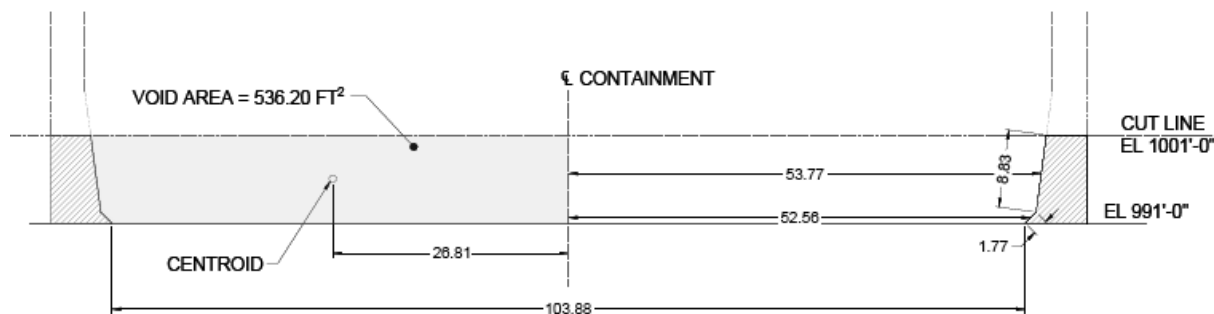


Figure 9 – Void Area Inside Containment & Sloped Wall Surface Area

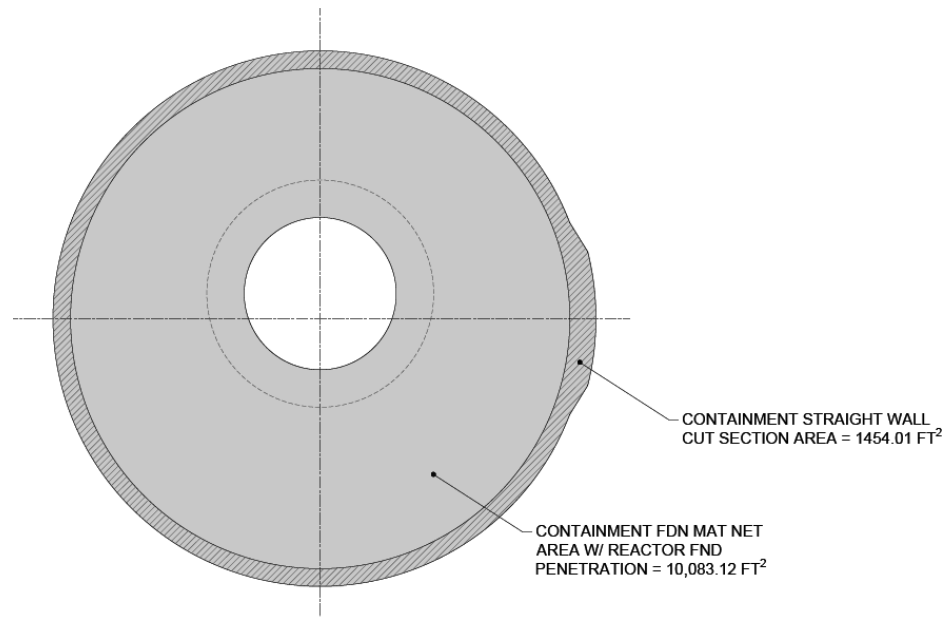


Figure 10 – Containment Foundation and Wall Areas

6.3 Turbine Building

6.3.1 Assumptions

- A. Turbine Generator pedestals are assumed to be cut at the same 1001' elevation assumed for the walls.
- B. Footings are not included in the concrete volume calculation. The only exception is at the heater drain pump, where the footing is included to account for the heater drain pump trench void.
- C. The linear footage includes the outer wall perimeter and pedestal perimeters.

6.3.2 Drawings Referenced

Item #	Drawing No.	Rev.	OPPD Doc. No.	Rev.		Item #	Drawing No.	Rev.	OPPD Doc. No.	Rev.
1	11405-A-258	26	12189	26		9	11405-S-293	6	16519	7
2	11405-S-91	4	16475	---		10	11405-S-294	5	16520	9
3	11405-S-92	7	16476	8		11	11405-S-305	6	16526	---
4	11405-S-93	5	16477	---		12	11405-S-306	4	16527	---
5	11405-S-94	4	16478	---		13	11405-S-307	4	16528	---
6	11405-S-95	5	16479	---		14	11405-S-430	3	16598	---
7	11405-S-291	7	16517	9		15	11405-S-431	4	16599	---
8	11405-S-292	5	16518	---						

6.3.3 Concrete Surface Area

Outer bldg walls:

Tot. wall perimeter = 884.00 ft AutoCAD Figure 12

Wall height =	11.00	ft	<i>from fdn @ EL 990' to cut line @ EL 1001'</i>
Tot. wall surface area =	9,724.00	ft²	

T/G pedestals (top of pedestals to be deducted from overall bldg fdn surface area):

Pedestals cut @ EL 1001'

Shape 1:	Perimeter (ea) =	34.58	ft	
	Height =	11.00	ft	<i>from fdn @ EL 990' to cut line @ EL 1001'</i>
	Wall surface area (ea) =	380.38	ft ²	
	Pedestal top area (ea) =	74.33	ft ²	<i>8' x 9'-3 1/2"</i>
	Net surface area (ea) =	454.71	ft ²	
	# of pedestals =	2.00		
	Total area =	909.42	ft ²	
Shape 2:	Perimeter (ea) =	50.00	ft	
	Height =	11.00	ft	<i>from fdn @ EL 990' to cut line @ EL 1001'</i>
	Wall surface area (ea) =	550.00	ft ²	
	Pedestal top area (ea) =	110.00	ft ²	
	Contact area w/ shape 7 =	-44.00	ft ²	<i>5'-6" x 4'-0" ea. end</i>
	Net surface area (ea) =	616.00	ft ²	
	# of pedestals =	2.00		
	Total area =	1,232.00	ft ²	
Shape 3:	Perimeter =	89.67	ft	
	Height =	11.00	ft	<i>from fdn @ EL 990' to cut line @ EL 1001'</i>
	Wall surface area =	986.37	ft ²	
	Pedestal top area =	193.33	ft ²	<i>40' x 4'-10"</i>
	Net surface area =	1,179.70	ft ²	
Shape 4:	Perimeter (ea) =	50.83	ft	
	Height =	11.00	ft	<i>from fdn @ EL 990' to cut line @ EL 1001'</i>
	Wall surface area (ea) =	559.13	ft ²	
	Pedestal top area (ea) =	161.00	ft ²	<i>13'-5" x 12'</i>
	Contact area w/ shape 6 =	-44.00	ft ²	<i>5'-6" x 4'-0" ea. end</i>
	Net surface area (ea) =	676.13	ft ²	
	# of pedestals =	2.00		
	Total area =	1,352.26	ft ²	
Shape 5:	Perimeter (ea) =	42.00	ft	
	Height =	11.00	ft	<i>from fdn @ EL 990' to cut line @ EL 1001'</i>
	Wall surface area (ea) =	462.00	ft ²	

Pedestal top area (ea) =	110.00	ft ²	10' x 11'
Net surface area (ea) =	572.00	ft ²	
# of pedestals =	2.00		
Total area =	924.00	ft ²	

Shape 6:	Wall surface area (ea) =	50.08	ft ²	AutoCAD Figure 15
	Bottom length =	14.82	ft	
	Thickness =	4.00	ft	
	Bottom surface area =	59.28	ft ²	
	Total area =	159.44	ft ²	2 x wall surf area + bottom

Shape 7:	Wall surface area (ea) =	42.50	ft ²	AutoCAD Figure 14
	Bottom length =	12.66	ft	
	Thickness =	4.00	ft	
	Bottom surface area =	50.64	ft ²	
	Total area =	135.64	ft ²	2 x wall surf area + bottom

Tot pedestal surf. area =	5,892.46	ft²
---------------------------	-----------------	-----------------------

Circ water pipe penetrations:

Surface area 66" hole (ea.):	-23.76	ft ²	Qty:	4
Surface area 90" hole (ea.):	-44.18	ft ²	Qty:	2
Total surface area =	-183.40	ft ²		

Bldg foundation @ EL 990':

Gross fdn surface area =	26,235.00	ft ²	AutoCAD Figure 12; inside outer walls only; includes T/G fdn; does not account for pits or voids	
Pedestal 1-5 top area =	1,103.99	ft ²	sum from calc above	
Net fdn surface area =	24,947.61	ft²	Gross surface area minus pedestal tops & cir water pens	

Sump pit walls, bottom EL 980'-3":

E/W walls:	Wall length =	11.00	ft
	Wall height =	9.75	ft
	Surface area =	107.25	ft ²
	# of walls =	2.00	

N/S walls:	Wall length =	13.00	ft
	Wall height =	9.75	ft
	Surface area =	126.75	ft ²
	# of walls =	2.00	

Tot wall area =	468.00	ft²
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Condensate pump pits:

Corregated pipe ID:	3.00	ft	
Inside circumference:	9.42	ft	
Depth:	22.00	ft	
Wall surface area ea. =	207.35	ft ²	<i>each pump</i>
# of pump pits =	3.00		
Tot surface area =	622.04	ft²	

T/G foundation trench:

Outer perimeter:	147.25	ft	
Block 1 perimeter:	39.70	ft	
Block 2 perimeter:	45.30	ft	
Total wall length:	232.25	ft	
Depth:	3.33	ft	
Wall surface area:	773.39	ft²	

Lube Oil Pad:	E/W wall length (ea) =	12.83	ft	<i>remaining walls accounted for in TB wall estimation</i>
	Tot wall length =	30.67	ft	
	Wall height =	0.50	ft	<i>EL 990' to 990'-6"</i>
	Total surface area =	15.33	ft²	

Heater drain pump pit:

Trench wall perimeter =	84.23	ft	
Trench depth =	3.75	ft	<i>includes 7" topping</i>
Trench wall surface area =	315.86	ft ²	
Corregated pipe ID =	2.00	ft	
Inside circumference:	6.28	ft	
Depth:	23.00	ft	
Wall Surface Area:	144.51	ft ²	<i>each pump</i>
# of pump pits =	3.00		
Tot pit wall surface area =	433.54	ft ²	
Total surface area =	749.40	ft²	

LINEAR FOOTAGE:	1,328	ft
FLOOR/FDN SURFACE AREA:	24,948	ft²
TOTAL OVERALL SURFACE AREA:	43,192	ft²

includes outer wall and pedestals only

6.3.4 Void Space

Overall gross building inside volume:

Area inside walls =	26,235.00	ft ²	<i>AutoCAD Figure 12</i>
Void height =	11.00	ft	<i>EL 990' to 1001'</i>
Void volume =	288,585.00	ft³	

Sump pit:

Pit area =	143.00	ft ²	<i>11' x 13'</i>
Void height =	9.75	ft	<i>EL 980'-3" to 990'</i>
Void volume =	1,394.25	ft³	

Condensate pump pits:

Corrugated pipe ID =	3.00	ft	
Pipe area =	7.07	ft	
Depth =	22.00	ft	
Pipe void volume ea. =	155.54	ft ³	
# of pump pits =	3.00		
Total void volume =	466.62	ft³	

T/G foundation trench:

Gross trench area =	798.04	ft ²	<i>AutoCAD Figure 11</i>
Block 1 area =	69.89	ft ²	<i>15'-3" x 4'-7"</i>
Block 2 area =	82.88	ft ²	<i>18'-1" x 4'-7"</i>
Net trench area =	645.27	ft ²	
Trench depth =	3.33	ft	
Net trench void volume =	2,150.88	ft³	

**Circ water pipe penetrations accounted for in Circ Water
 Pipe calculation**

Lube Oil Pad concrete volume = **-263.92 ft³** *from concrete vol. calc.*

Heater drain pump pit:

Trench area =	132.17	ft ²	<i>AutoCAD Figure 11</i>
Trench depth =	3.75	ft	
Trench void volume =	495.64	ft ³	
Corrugated pipe ID =	2.00	ft	
Inside area =	3.14	ft ²	
Depth =	23.00	ft	
Void volume ea. =	72.26	ft ³	

of pump pits = 3.00
 Tot pit void volume = 216.77 ft³

Total void volume = **712.41 ft³**

Pedestal concrete volume = **-12,514.21 ft³**

TOTAL VOID VOLUME = 280,531 ft³

6.3.5 Concrete Volume

Outer bldg walls:

Cut section area = 1,822.00 ft² *AutoCAD Figure 12*
 Wall height = 11.00 ft *from fdn @ EL 990' to cut line @ EL 1001'*
 Concrete volume = **20,042.00 ft³**

Bldg foundation @ EL 990':

Footings (other than heater drain pit footing) considered deep foundations for structural support only - excluded from analysis.

Gross bldg fdn area = 29,992.00 ft² *AutoCAD Figure 12*
 T/G fdn area = 7,332.00 ft² *156' x 47'*
 Net bldg fdn area = 22,660.00 ft² *Gross bldg fdn area - T/G fdn area*
 Building fdn thickness = 2.58 ft *Includes 7" topping; doesn't include thickness of footings*
 Concrete volume = **58,538.26 ft³**

T/G pedestals:

Pedestals cut @ EL 1001'

Shape 1:	Area =	74.33	ft ²	8' x 9'-3 1/2"
	Height =	11.00	ft	
	Concrete volume ea. =	817.63	ft ³	
	# of pedestals =	2.00		
	Total concrete volume =	1,635.26	ft ³	
Shape 2:	Area =	110.00	ft ²	
	Height =	11.00	ft	
	Concrete volume ea. =	1,210.00	ft ³	
	# of pedestals =	2.00		
	Total concrete volume =	2,420.00	ft ³	
Shape 3:	Area =	193.33	ft ²	40' x 4'-10"
	Height =	11.00	ft	
	Concrete volume =	2,126.63	ft ³	
Shape 4:	Area =	161.00	ft ²	13'-5" x 12'

FCS Bldg End State Concrete Surface Areas & Volumes

	Height =	11.00	ft	
	Concrete volume ea. =	1,771.00	ft ³	
	# of pedestals =	2.00		
	Total concrete volume =	3,542.00	ft ³	
Shape 5:	Area =	110.00	ft ²	10' x 11'
	Height =	11.00	ft	
	Concrete volume ea. =	1,210.00	ft ³	
	# of pedestals =	2.00		
	Total concrete volume =	2,420.00	ft ³	
Shape 6:	Area =	50.08	ft ²	AutoCAD Figure 15
	Thickness =	4.00	ft	
	Concrete volume =	200.32	ft ³	
Shape 7:	Area =	42.50	ft ²	AutoCAD Figure 14
	Thickness =	4.00	ft	
	Concrete volume =	170.00	ft ³	
	Total pedestal conc. vol. =	12,514.21	ft³	
Sump pit:	Slab void area =	143.00	ft ²	11' x 13'
	Slab depth =	2.58	ft	
	Slab void volume =	-368.94	ft ³	
	Wall cross section area =	52.00	ft ²	
	Depth below slab =	7.17	ft	
	Wall conc. volume =	372.84	ft ³	
	Pit floor area =	224.00	ft ²	16' x 14'
	Floor thickness =	1.00	ft	
	Floor conc. volume =	224.00	ft ³	
	Net concrete volume =	227.90	ft³	
Condensate pump pits:				
	Pit OD =	5.00	ft	
	Pit ID =	3.00	ft	
	Area =	12.57	ft ²	
	Depth below footing =	19.42	ft	
	Concrete volume (ea) =	244.06	ft ³	Qty = 3
	Concrete volume tot =	732.18	ft ³	
	Pit floor OD =	5.00	ft	
	Area =	28.27	ft ²	
	Floor thickness =	1.50	ft	
	Concrete volume (ea) =	42.41	ft ³	Qty = 3
	Concrete volume tot =	127.22	ft ³	

Total concrete volume = **859.39 ft³**

T/G foundation trench:

Net trench area = 645.27 ft² *See void space calc*
 Trench depth = -3.33 ft
 Net trench void volume = **-2,148.75 ft³**

Circ water pipe penetrations:

Area 66" hole (ea.): 23.76 ft² Qty: 4
 Area 90" hole (ea.): 44.18 ft² Qty: 2
 Total surface area = 183.40 ft²
 Slab thickness = -2.58 ft
 Penetration void volume = **-473.17 ft³**

Lube Oil Pad:

Pad area = 527.83 ft² *AutoCAD Figure 11*
 Pad height = 0.50 ft
 Pad conc. volume = **263.92 ft³**

Heater drain pump pit:

Trench area = 132.17 ft² *AutoCAD Figure 11*
 Trench depth = -3.75 ft
 Trench void volume = -495.64 ft³

 Pit OD = 4.00 ft
 Pit ID = 2.00 ft
 Area = 9.42 ft²
 Depth below footing = 17.25 ft
 Concrete volume (ea) = 162.50 ft³ Qty = 3
 Concrete volume tot = 487.49 ft³

 Pit floor OD = 4.00 ft
 Area = 12.57 ft²
 Floor thickness = 1.50 ft
 Concrete volume (ea) = 18.86 ft³ Qty = 3
 Concrete volume tot = 56.57 ft³

 Total concrete volume = **48.41 ft³**

T/G foundation:

North end: Width = 47.00 ft
 Length = 103.33 ft
 Thickness = 9.00 ft

FCS Bldg End State Concrete Surface Areas & Volumes

Concrete volume =

43,708.59 ft³

South end: Width =

47.00 ft

Length =

52.67 ft

Thickness =

12.33 ft

Concrete volume =

30,522.79 ft³

Footing @ Heater Drain Pump Trench:

Width =

22.92 ft

Length =

21.67 ft

Thickness =

3.17 ft

only considers concrete below 2' slab

Concrete volume =

1,572.48 ft³

FLOOR/FDN CONCRETE VOLUME: 131,720 ft³

TOTAL CONCRETE VOLUME = 165,676 ft³

6.3.6 Figures

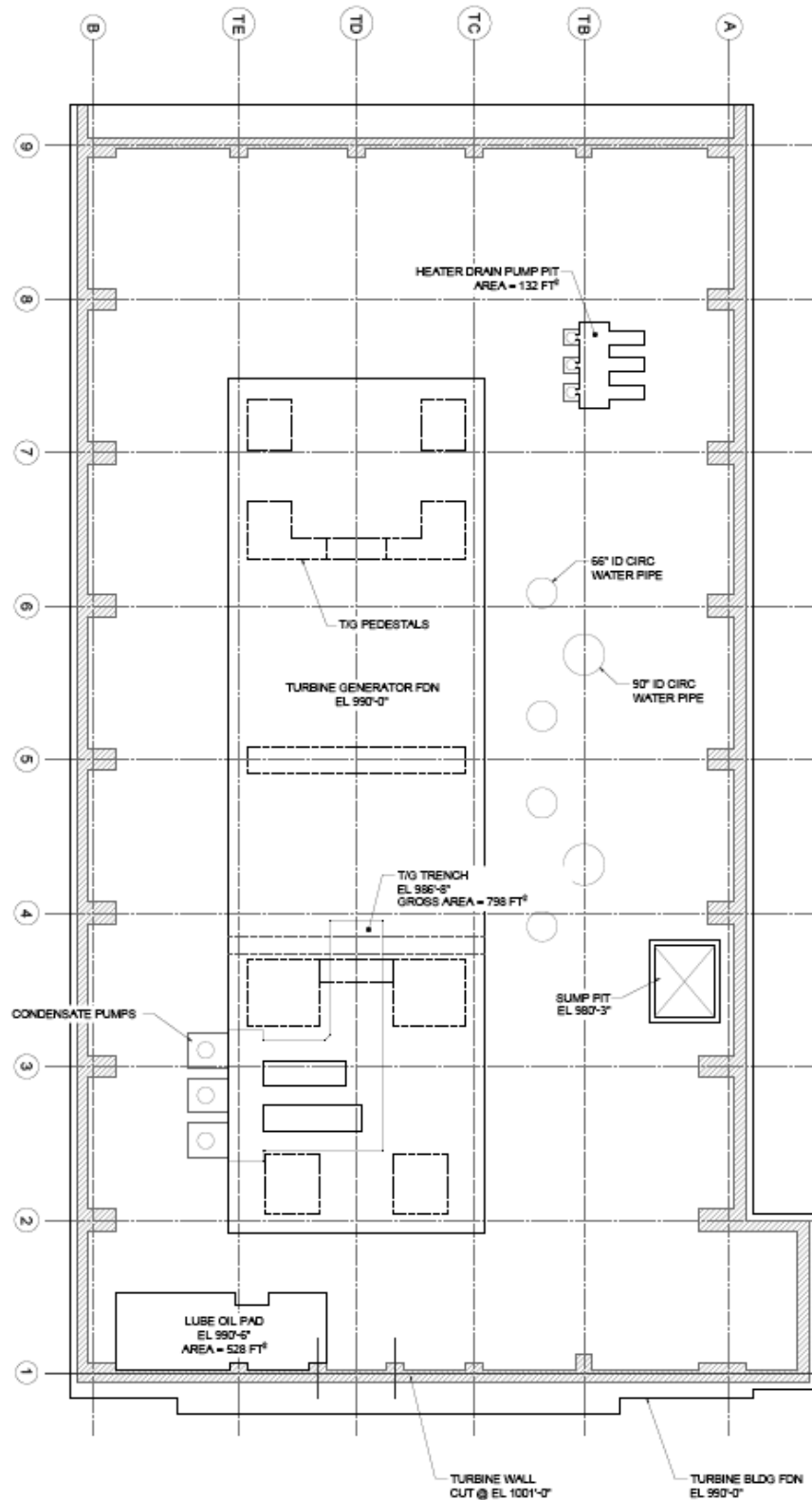


Figure 11 – Turbine Building General Arrangement Plan View

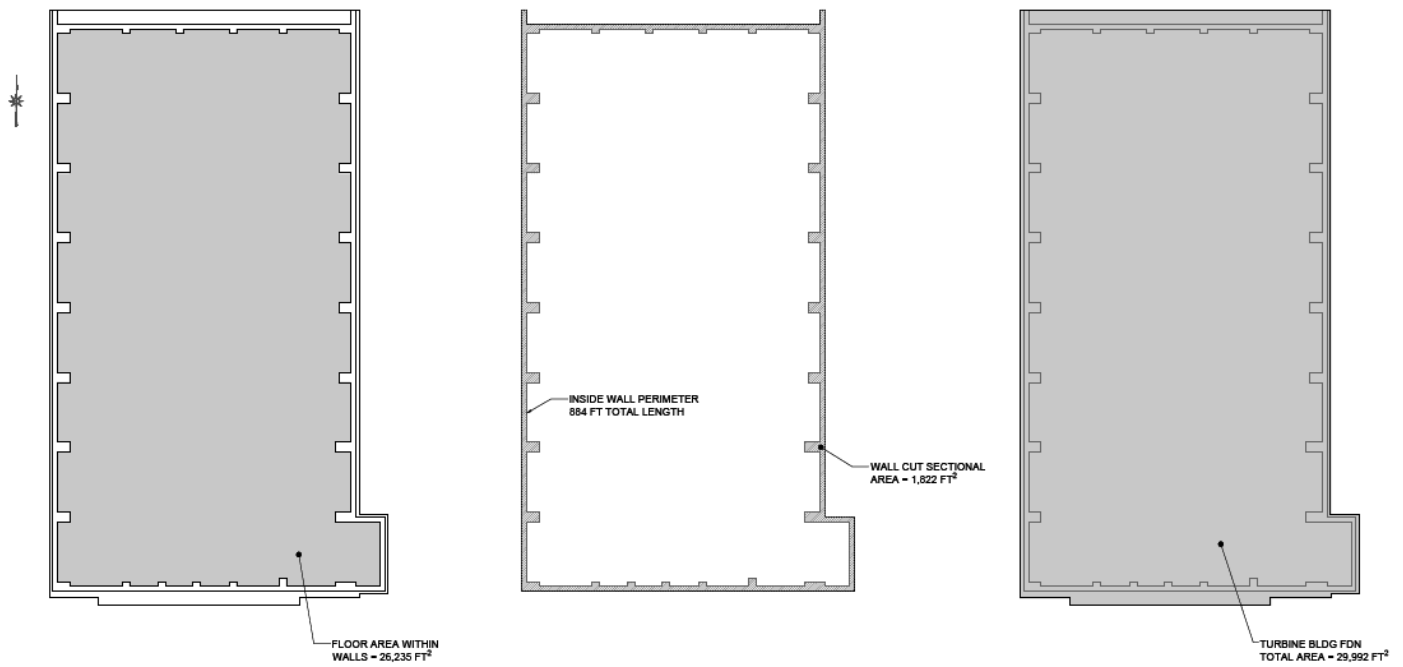


Figure 12 – Turbine Bldg Foundation and Wall Areas

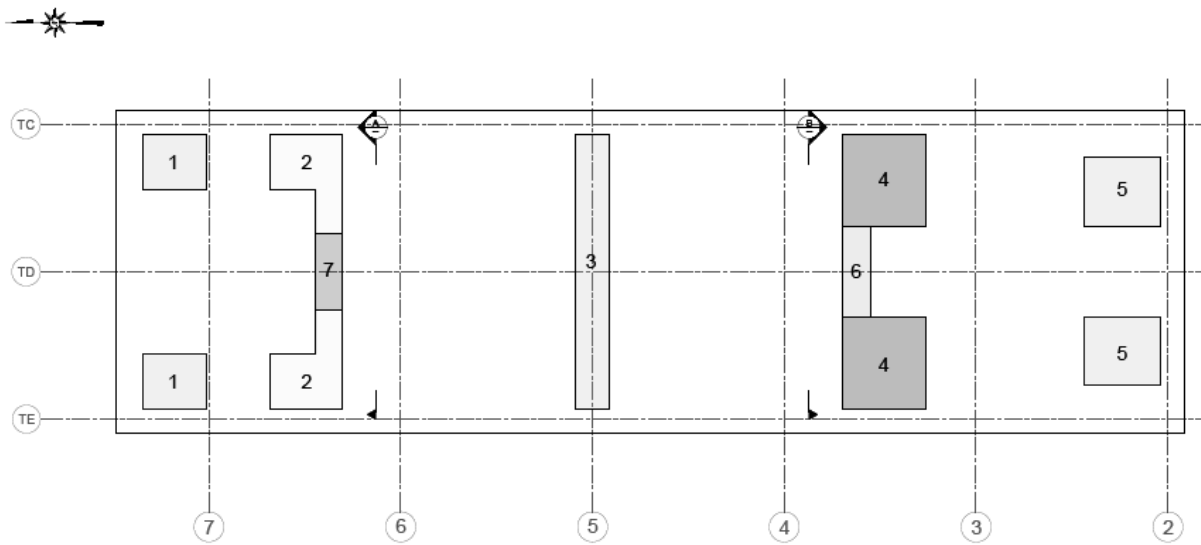


Figure 13 – Turbine Generator Pedestal Layout

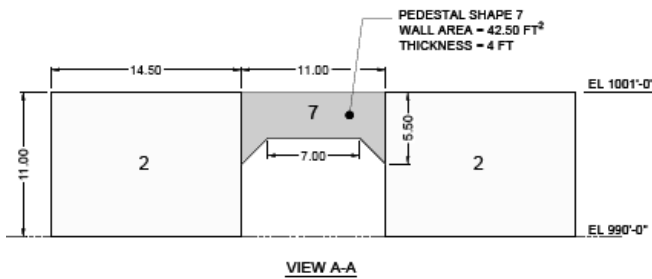


Figure 14 – Pedestal View A-A

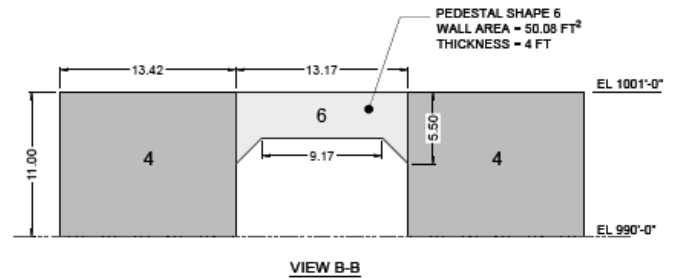


Figure 15 – Pedestal View B-B

6.4 Circ Water Tunnels

6.4.1 Assumptions

- A. The roof of the upper intake room at the intake structure splits the EL 1001' cut elevation, so it is assumed that the roof will be fully removed.
- B. The concrete surface area and volume were not further broken down to isolate the floors and foundations for the circ water tunnels.

6.4.2 Drawings Referenced

Item #	Drawing No.	Rev.	OPPD Doc. No.	Rev.
1	11405-S-300	---	16523	---
2	11405-S-301	5	16524	---
3	11405-S-299	7	16522	---
4	11405-S-311	6	16531	2
5	11405-S-317	6	16537	8

6.4.3 Concrete Surface Area

90" Discharge Tunnel

90 deg elbow:	Elbow radius =	11.25	ft
	$L = 0.25\pi D =$	17.67	ft
	90" pipe circumf. =	23.56	ft
	Surface area ea. =	416.34	ft ²
	Qty =	2.00	
	Tot surface area =	832.68	ft²

Angled run:	Length =	86.18	ft	AutoCAD Figure 16
	Perimeter =	32.00	ft	7'-6" x 8'-6" rectangular tunnel

Surface area ea. = 2,757.76 ft²
 Qty = 2.00
 Tot surface area = **5,515.52 ft²**

Straight run: Length = 9.80 ft *from angle junction to intake structure*
 Perimeter = 34.00 ft *8'-6" x 8'-6" rectangular tunnel*
 Surface area = **333.27 ft²**

Room @ intake structure (down to screen house tunnel interface):

Wall lengths (ft): N = 21.17 E = 82.92 W = 74.42
accounts for tunnel opening @ SW corner
 Wall perimeter = 178.50 ft
 Wall height = 14.17 ft
 Tot wall area = 2,528.80 ft²
 Floor area = 1,755.07 ft² *21'-2" x 82'-11"*
 Ceiling area = 1,755.07 ft²
 Tot surface area = **6,038.94 ft²**

Screen house tunnels:

NE wall length = 110.02 ft *AutoCAD Figure 20*
 SW wall length = 151.40 ft *AutoCAD Figure 20*
 Wall height = 14.17 ft
 Tot wall area = 3,703.45 ft²
 Ceiling area = 3,133.97 ft² *AutoCAD Figure 20*
 Floor area = 3,133.97 ft² *AutoCAD Figure 20*
 Divider wall perim. = 44.00 ft *20' x 2' x 14.17'*
 Divider wall area = 623.33 ft²
 2 ft dia. column circ. = 6.28 ft
 Column area ea. = 89.01 ft²
 Column qty = 6.00
 Tot column area = 534.07 ft²
 Tot surface area = **11,128.79 ft²**

TOT DISCH. SURFACE AREA = 23,849.20 ft²

66" Intake Tunnel

Tunnel from TB to bottom of slope:

Floor area = 427.32 ft² *AutoCAD Figure 16*
 66" penetration area = 23.76 ft²
 Ceiling area = 379.80 ft² *deducting area from (2) penetrations*
 Wall perimeter = 120.06 ft *AutoCAD Figure 16*

Wall height = 8.50 ft
 Wall area = 1,020.48 ft²

Tot area (North) = 1,827.60 ft²
 Tot area (South) = 1,827.60 ft²
 Tot surface area = **3,655.19 ft²**

Sloped portion: Floor area = 173.73 ft² *from AutoCAD in pure plan view - must adjust for slope*
 Adjusted for 45 deg = 245.69 ft² *(Area/cos 45°) AutoCAD Figure 16*
 Ceiling area = 245.69 ft²
 Wall length = 15.54 ft
 Adjusted for 45 deg = 21.98 ft
 Divider wall arc length = 6.92 ft
 Tot wall length = 50.88 ft *includes (2) straight walls and rounded divider wall*
 Wall height = 8.50 ft
 Tot wall area = 432.47 ft²
 Tot surface area = **923.86 ft²**

Straight run from top of slope to room @ intake structure:
 Inside tunnel perimeter = 34.00 ft *8'-6" x 8'-6"*
 Tunnel length = 63.59 ft
 Tot surface area = **2,162.06 ft²**

Room @ intake structure (assume no ceiling; walls cut at EL 1001'):
 Floor area = 665.54 ft² *AutoCAD Figure 19*
 Wall perimeter = 140.35 ft *AutoCAD Figure 19*
 Wall height = 9.00 ft *EL 992'-0" to EL 1001'-0"*
 Wall area = 1,263.15 ft²
 Tot surface area = **1,928.69 ft²**

TOT INTAKE SURFACE AREA = 8,669.80 ft²

Linear footage: *AutoCAD Figure 31*
 90" tunnel inner wall perimeter = 359.54 ft
 66" tunnel inner wall perimeter = 385.64 ft
 Straight tunnel length = 14.26 ft
 Lower room perimeter = 178.47 ft
 Upper room perimeter = 140.35 ft
 Discharge tunnel NE wall length = 110.02 ft
 Discharge tunnel SW wall length = 151.40 ft
 x4 walls = 57.04 ft

LINEAR FOOTAGE: 1,382 ft

TOTAL OVERALL SURFACE AREA: 32,519 ft²

6.4.4 Void Space

90 deg elbow:

90" pipe area =	44.18	ft ²	$\pi D^2/4$
Pipe length =	17.67	ft	
Void volume ea. =	780.73	ft ³	
Qty =	2.00		
Tot void volume =	1,561.45	ft³	

Angled run:

Tunnel area =	63.75	ft ²	7'-6" x 8'-6" rectangular tunnel
Tunnel length =	86.18	ft	AutoCAD Figure 16
Void volume ea. =	5,493.98	ft ³	
Qty =	2.00		
Tot void volume =	10,987.95	ft³	

Straight run:

Tunnel area =	72.25	ft ²	8'-6" x 8'-6" rectangular tunnel
Tunnel length =	9.80	ft	from angle junction to intake structure
Void volume =	708.19	ft³	

Room @ intake structure (down to screen house tunnel interface):

Floor area =	1,755.07	ft ²	21'-2" x 82'-11"
Void height =	14.17	ft	
Void volume =	24,863.48	ft³	

Screen house tunnels:

Floor area =	3,133.97	ft ²	AutoCAD Figure 20
Divider area =	40.00	ft ²	20' x 2'
Net area =	3,093.97	ft ²	Floor area - divider area
Void height =	14.17	ft	
Net void volume =	43,841.55	ft³	Net area x void height

TOT DISCH. VOID VOLUME =	81,963	ft³
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66" Intake Tunnel

Tunnel from TB to bottom of slope:

Floor area =	427.32	ft ²	AutoCAD Figure 16
Void height =	8.50	ft	
Void volume (North) =	3,632.22	ft ³	

Void volume (South) = 3,632.22 ft³
 Tot void volume = **7,264.44 ft³**

Sloped portion:

Floor area = 245.69 ft² *Adjusted for 45 deg slope*
 Void height = 8.50 ft
 Void volume = **2,088.38 ft³**

Straight run from top of slope to room @ intake structure:

Tunnel cross section = 72.25 ft² *8'-6" x 8'-6"*
 Tunnel length = 63.59 ft
 Void volume = **4,594.38 ft³**

Room @ intake structure (assume no ceiling; walls cut at EL 1001'):

Floor area = 665.54 ft² *AutoCAD Figure 19*
 Void height = 9.00 ft *EL 992'-0" to EL 1001'-0"*
 Void volume = **5,989.86 ft³**

TOT INTAKE VOID VOLUME = 19,937 ft³

TOTAL VOID VOLUME = 101,900 ft²

6.4.5 Concrete Volume

Lower level gross volume from TB to 19' past line SA:

Gross area = 3,955.50 ft² *AutoCAD Figure 17*
 Height = 13.50 ft
 Gross volume = **53,399.25 ft³**

Upper level gross volume from bottom of slope to 19' past line SA:

Gross area = 931.92 ft² *AutoCAD Figure 18*
floor is accounted for with lower level ceiling
 Height = 11.00 ft
 Gross volume = **10,251.12 ft³**

Straight run from 19' past line SA to intake structure:

Gross cross section area = 330.75 ft² *24'-6" x 13'-6"*
 Run length = 9.83 ft
 Gross volume = **3,252.37 ft³**

Total void volume from TB to intake structure (from void volume calc):

Void volume = **-27,204.79 ft³**

Room @ intake structure (down to screen house tunnel interface):

Ceiling volume =	6,398.41	ft ³	2'-10" x 25'-10" x 87'-5"
Floor volume =	6,398.41	ft ³	
East wall volume =	2,377.20	ft ³	2'-4" x 14'-2" x 71'-11" (accounts for opening)
West wall volume =	2,823.56	ft ³	2'-4" x 14'-2" x 85'-5"
North wall volume =	731.94	ft ³	2'-0" x 25'-10" x 14'-2"
Total concrete volume =	18,729.52	ft³	

Screen house tunnels:

SW wall cross section area =	383.25	ft ²	AutoCAD Figure 20
NE wall cross section area =	250.87	ft ²	AutoCAD Figure 20
Total wall area =	634.12	ft ²	
Wall height =	14.17	ft	
Wall concrete volume =	8,983.32	ft ³	

Ceiling concrete area =	3,769.23	ft ²	AutoCAD Figure 20
Floor concrete area =	3,769.23	ft ²	
Total concrete area =	7,538.46	ft ²	
Thickness =	2.83	ft	
Total concrete volume =	21,358.94	ft ³	

Total concrete volume = **30,342.27 ft³**

66" Intake Tunnel

Room @ intake structure (assume no ceiling; walls cut at EL 1001'):

Ceiling splits the EL 1001' cut line, so it is assumed that the ceiling will be removed

Wall cut section area =	355.66	ft ²	AutoCAD Figure 19
Wall height =	8.50	ft	
Wall concrete volume =	3,023.11	ft³	

Note that floor is accounted for with discharge room ceiling

TOTAL CONCRETE VOLUME = 91,793 ft²

6.4.6 Figures

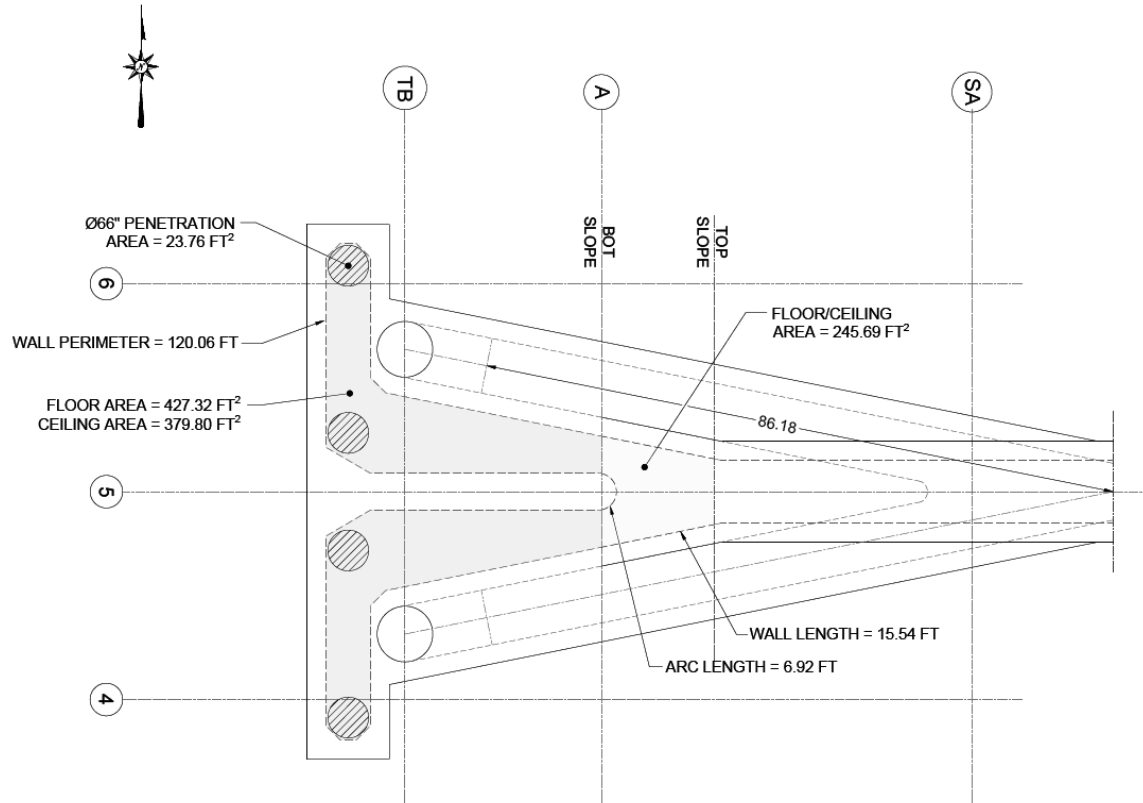


Figure 16 – Circ Water Discharge Tunnels at the Turbine Building

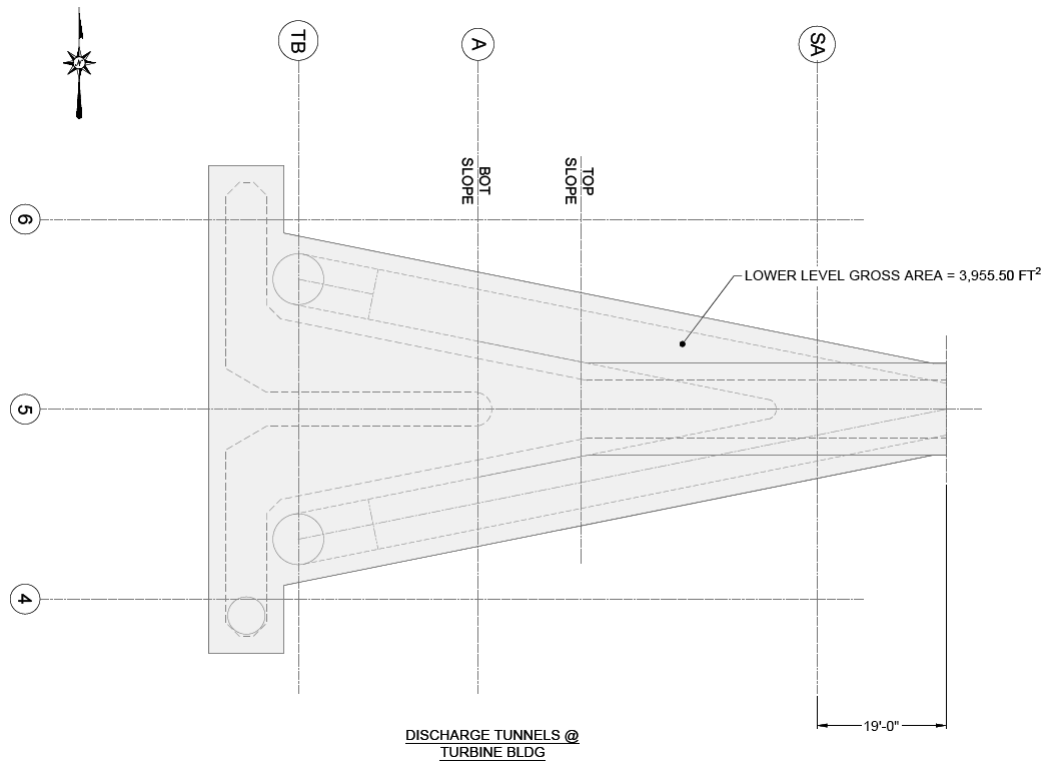


Figure 17 – Discharge Tunnel Gross Concrete Area

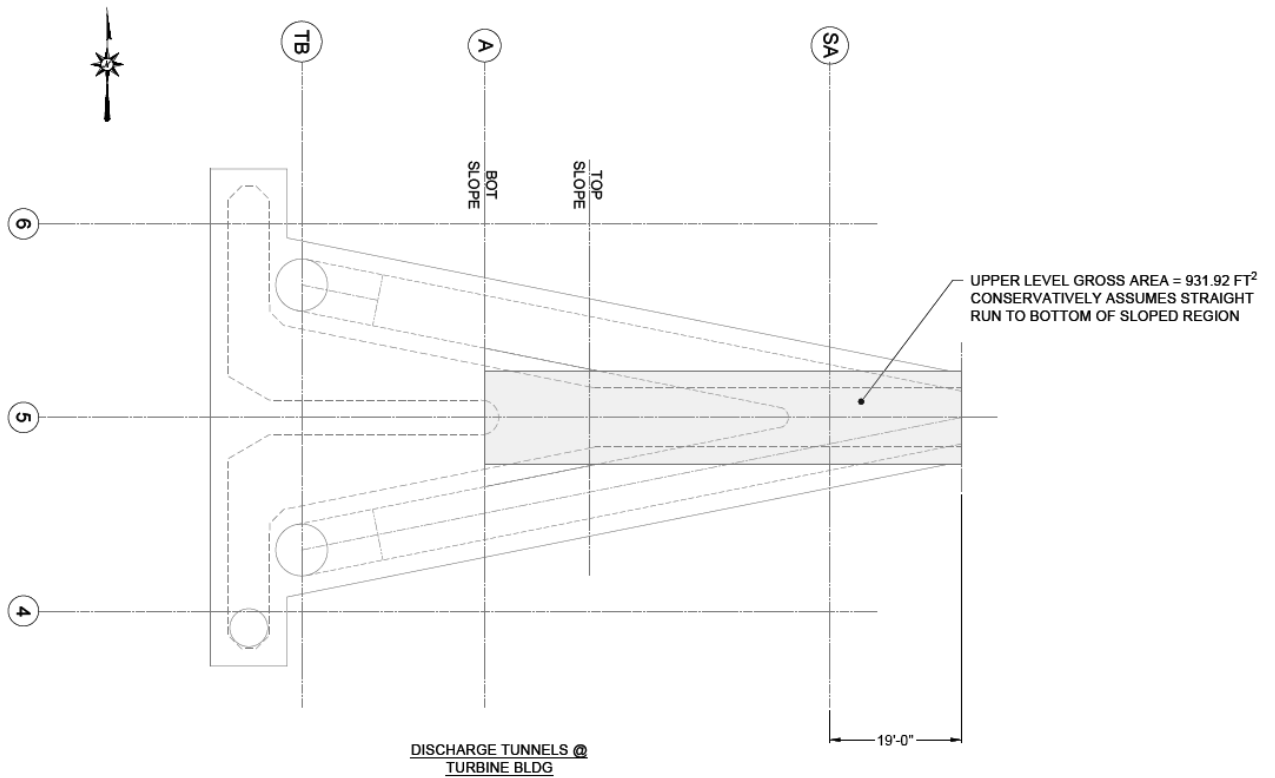


Figure 18 – Intake Tunnel Gross Concrete Area

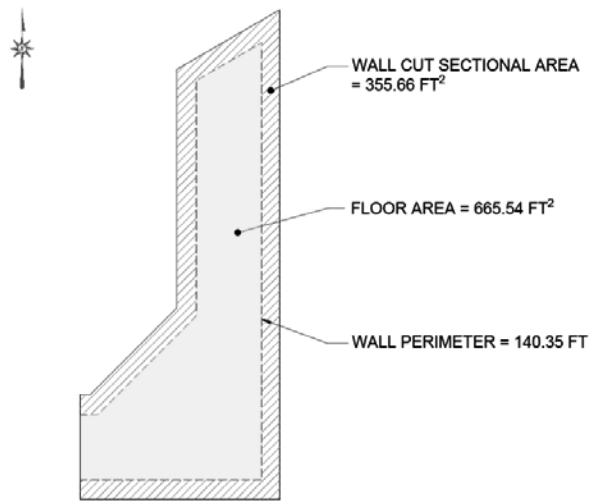


Figure 19 – Upper Room West of Intake Structure

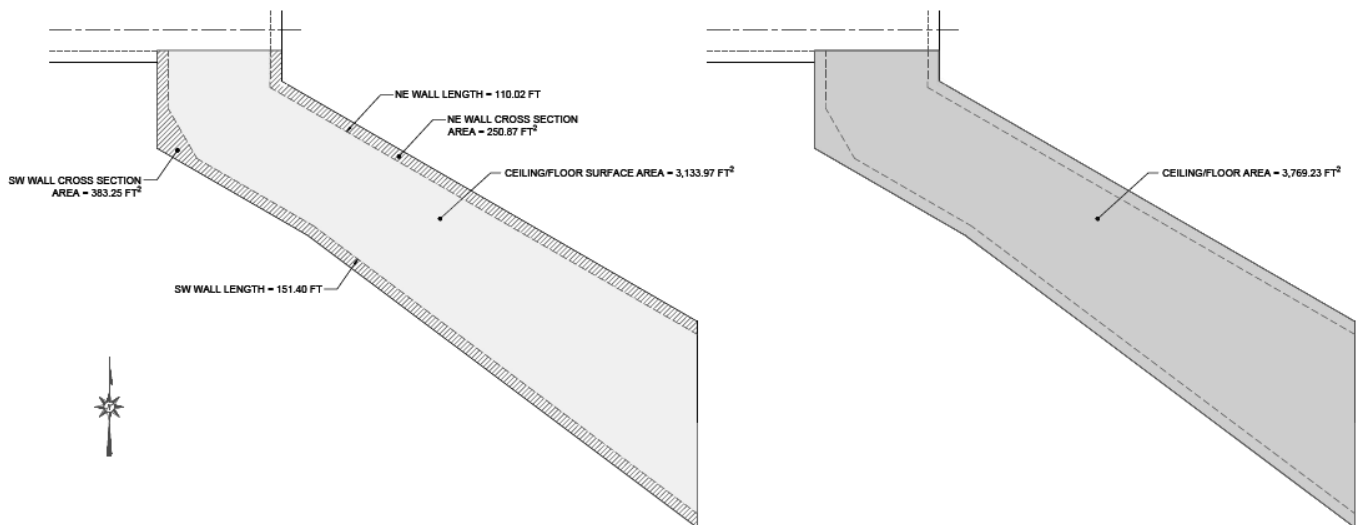


Figure 20 – Discharge Tunnel at Screen House

6.5 Intake Structure

6.5.1 Assumptions

- A. All interior walls will be removed except the east-most walls at the river interface.
- B. The calculation does not account for any gates that may be left in place at the river interface.
- C. The floor and foundation surface area total includes all dividers and circ water pumps.

6.5.2 Drawings Referenced

Item #	Drawing No.	Rev.	OPPD Doc. No.	Rev.
1	11405-S-311	6	16531	2
2	11405-S-312	15	16532	15
3	11405-S-313	24	16533	24
4	11405-S-315	11	16535	11
5	11405-S-316	8	16536	11

6.5.3 Concrete Surface Area

SW room @ EL 994'-6":

Floor area =	173.61	ft ²	20'-10" x 8'-4"; includes tops of cut walls #3 & 5
Wall perimeter =	24.00	ft	18' x 6'; open on two sides
Wall height =	6.50	ft	EL 994'-6" to 1001'
Wall area =	156.00	ft ²	
Total area =	329.61	ft²	Floor area + wall area

S room @ EL 985'-0":

Floor area =	280.56	ft ²	33'-8" x 8'-4"; includes top of cut wall #3
East wall length =	8.33	ft	
Wall height =	16.00	ft	EL 985' to 1001'
East wall area =	133.28	ft ²	
South wall length =	33.66	ft	
Wall height =	16.00	ft	EL 985' to 1001'
South wall area =	538.56	ft ²	
West wall length =	8.33	ft	
Wall height =	9.50	ft	EL 985' to 994'-6"
West wall area =	79.14	ft ²	
Total area =	1,031.54	ft²	Floor area + wall areas

W room @ EL 974'-8" floor area =

2,359.00 ft²

AutoCAD Figure 21; accounts for penetrations

Wall #1 (North) surface area =

2,171.00 ft²

AutoCAD Figure 25

Wall #3 (South) surface area =

1,799.98 ft²

AutoCAD Figure 26

West Wall:

Wall length @ 975' =	10.33	ft	
Wall height =	26.00	ft	EL 975' to 1001'
Wall length @ 974'-8" =	63.67	ft	
Wall height =	26.33	ft	EL 974'-8" to 1001'
Gross wall surf. Area =	1,945.01	ft ²	

Tunnel penetration =	64.00	ft ²	8'x8'
Net wall surf. Area =	1,881.01	ft²	

N room @ EL 975'-0":

Floor area =	833.00	ft ²	AutoCAD Figure 21
East bay perimeter =	30.00	ft	11'x8'x11'
Wall height =	26.00	ft	EL 975' to 1001'
Gross wall area =	780.00	ft ²	
Penetration area =	48.00	ft ²	6' x 8'
Net wall area =	732.00	ft ²	
Inner east wall length =	10.33		
Wall height =	26.00	ft	EL 975' to 1001'
Gross wall area =	268.58	ft ²	
Penetration area =	48.00	ft ²	6' x 8'
Net wall area =	220.58	ft ²	
Total surface area =	1,785.58	ft²	

Sloped region:

Floor area (flat) =	1,630.83	ft ²	from AutoCAD in pure plan view - must adjust for slope
Floor area (sloped) =	1,643.08	ft²	Adjusted for slope (Area/cos 7°) Figure 21

Dividers:

Divider perimeter =	30.31	ft	
Divider height =	5.17	ft	EL 967' (@ mid divider) to 973'-2"
Divider wall area (ea.) =	156.60	ft ²	
Number of dividers =	3.00		
Tot divider wall area =	469.80	ft²	
Divider floor area (ea.) =	126.04	ft ²	
Number of dividers =	3.00		
Tot divider floor area =	378.12	ft²	

East Wall:

Wall length =	63.67	ft	
Wall height =	31.00	ft	EL 970' to 1001'
Cutout area (ea) =	48.00	ft ²	6' x 8'
Number of cutouts =	6.00		
Tot cutout area =	288.00	ft ²	
Net wall area =	1,685.77	ft²	Gross wall area - cutout area

Circ Water Pumps:

Floor area =	126.13	ft ²	AutoCAD Figure 27
Ceiling area =	95.45	ft ²	accounts for penetration
Wall perimeter =	44.56	ft	
Wall height =	7.00	ft	
Wall area =	311.92	ft ²	
Tot area per pit =	533.50	ft ²	

Number of sump pits = 3.00
 Total sump pit area = **1,600.49 ft²**

E rooms @ EL 970:

Floor area per bay = 95.92 ft² *AutoCAD Figure 21*
 Wall perimeter per bay = 30.66 ft
 Wall height = 31.00 ft *EL 970' to 1001'*
 Wall area per bay = 1,105.46 ft²
 Penetration area ea. = 48.00 ft² *6' x 8'*
 Net wall area per bay = 1,057.46 ft²
 Number of bays = 6.00
 Total surface area = **5,990.28 ft²**

LINEAR FOOTAGE:	306	ft
FLOOR/FDN SURFACE AREA:	6,369	ft²
TOTAL OVERALL SURFACE AREA:	23,125	ft²

AutoCAD Figure 32

Includes dividers, circ water pumps

6.5.4 Void Space

SW room @ EL 994'-6":

Floor area = 173.60 ft² *20'-10" x 8'-4"*
 Void height = 6.50 ft *EL 994'-6" to 1001'*
 Void volume = **1,128.40 ft³**

S room @ EL 985'-0":

Floor area = 280.55 ft² *33'-8" x 8'-4"*
 Void height = 16.00 ft *EL 985' to 1001'*
 Void volume = **4,488.80 ft³**

W room @ EL 974'-8":

Floor area = 2,451.17 ft² *38'-6" x 63'-8"*
 Void height = 26.33 ft *EL 974'-8" to 1001'*
 Void volume = **64,547.47 ft³**

N room @ EL 975'-0":

Floor area = 833.00 ft² *AutoCAD Figure 21*
 Void height = 26.00 ft *EL 975' to 1001'*
 Void volume = **21,658.00 ft³**

Sloped region:

Below EL 974'-8": Cross section area = 214.51 ft² *AutoCAD Figure 24*
 Above EL 974'-8": Cross section area = 842.67 ft² *32'L x 26'-4"H*
 Gross cross section = 1,057.18 ft²

FCS Bldg End State Concrete Surface Areas & Volumes

Room width =	63.67	ft	<i>gross cross section x room width</i>
Gross void volume =	67,310.65	ft ³	<i>does not account for dividers</i>
Total divider volume =	2,333.00	ft ³	<i>from concrete volume calculation</i>
Net void volume =	64,977.65	ft³	<i>gross void volume - tot divider volume</i>

East Wall: Cutout area (ea) =	48.00	ft ²	<i>6' x 8'</i>
Wall thickness =	2.00	ft	
Void vol per cutout =	96.00	ft ³	
Number of cutouts =	6.00		
Tot void volume =	576.00	ft³	

Circ Water Pumps:	75" dia. penetration area		
=	30.68	ft ²	
Ceiling thickness =	1.50	ft	
Penetration void volume			
=	46.02	ft ³	
Floor area =	105.00	ft ²	<i>15' X 7'</i>
Void height =	7.00	ft	
Void volume ea. =	735.00	ft ³	
Tot void vol ea. =	781.02	ft ³	<i>Penetration + sump void</i>
Qty =	3.00		
Total void volume =	2,343.06	ft³	

E rooms @ EL 970:

Floor area per bay =	95.92	ft ²	<i>AutoCAD Figure 21</i>
Void height =	31.00	ft	<i>EL 970' to 1001'</i>
Void volume per bay =	2,973.52	ft ³	
Number of bays =	6.00		
Total void volume =	17,841.12	ft³	

TOTAL VOID VOLUME:	177,560	ft³
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6.5.5 Concrete Volume

SW room @ EL 994'-6" floor volume =	399.69	ft³	<i>9.83' x 20.33' x 2'</i>
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S room @ EL 985'-0" floor volume =	773.23	ft³	<i>9.83' x 39.33' x 2'</i>
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Walls #1 to 6 (See Figure #):

Wall #1 cross sectional area =	2,171.00	ft ²	<i>AutoCAD Figure 25</i>
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Wall thickness =	2.83	ft	
Wall #1 concrete volume =	6,151.17	ft ³	
Wall #2 cut sectional area =	184.72	ft ²	<i>AutoCAD Figure 22</i>
Wall height =	26.33	ft	<i>EL 974'-8" to 1001'</i>
Tunnel penetration =	144.00	ft ³	<i>8'x8'x2'-3"</i>
Wall #2 concrete volume =	4,720.29	ft ³	<i>Accounts for tunnel penetration</i>
Wall #3 cross sectional area =	1,799.98	ft ²	<i>AutoCAD Figure 26</i>
Wall thickness =	2.33	ft	
Wall #3 concrete volume =	4,199.95	ft ³	
Wall #4 cut sectional area =	71.61	ft ²	<i>AutoCAD Figure 22</i>
Wall height =	6.50	ft	<i>EL 994'-6" to 1001'</i>
Wall #4 concrete volume =	465.47	ft ³	
Wall #5 cut sectional area =	17.00	ft ²	<i>AutoCAD Figure 22</i>
Wall height =	9.50	ft	<i>EL 985' to 994'-6"</i>
Wall #5 concrete volume =	161.50	ft ³	
Wall #6 cut sectional area =	128.44	ft ²	<i>AutoCAD Figure 22</i>
Wall height =	16.00	ft	<i>EL 985' to 1001'</i>
Wall #6 concrete volume =	2,055.04	ft ³	

Total wall concrete volume =

17,753.41 ft³

Structure
 foundation:

South:	Cross sectional area =	608.83	ft ²	<i>AutoCAD Figure 23; does not account for sump pits</i>
	Fdn width =	66.00	ft	
	Fdn volume =	40,182.78	ft ³	
	Cir water void volume ea. =	-781.02	ft ³	
	Number of sumps =	3.00		
	Total sump void volume =	-2,343.06	ft ³	
	Net Fdn volume South =	37,839.72	ft ³	
North:	Cross sectional area =	916.55	ft ²	<i>AutoCAD Figure 28</i>
	Fdn width =	13.17	ft	
	Fdn volume North =	12,070.96	ft ³	

Total foundation volume =

49,910.68 ft³

East Walls:	Cut section area =	252.75	ft ²	<i>AutoCAD Figure 22; includes dividers at river</i>
	Wall height =	31.00	ft	<i>EL 970' to 1001'</i>
	Cutout void volume =	576.00	ft ³	<i>From void volume calc</i>
	Net wall volume =	7,259.25	ft³	<i>Wall volume - void volume</i>

Northeast

Walls:	Cut section area =	45.75	ft ²	<i>AutoCAD Figure 22</i>
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FCS Bldg End State Concrete Surface Areas & Volumes

Wall height =	26.00	ft	<i>EL 975' to 1001'</i>
Cutout void volume =	48.00	ft ³	<i>6'x8'</i>
Net wall volume =	1,141.50	ft³	<i>Wall volume - void volume</i>

Dividers:	Divider area (ea) =	126.04	ft ²	
	Height =	6.17	ft	<i>measured at middle of divider</i>
	Divider volume (ea) =	777.67	ft ³	
	Number of dividers =	3.00		<i>(2) full + (2) half</i>
	Total divider volume =	2,333.00	ft³	

FLOOR/FDN CONCRETE VOLUME:	51,084	ft³
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TOTAL CONCRETE VOLUME:	79,571	ft³
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6.5.6 Figures

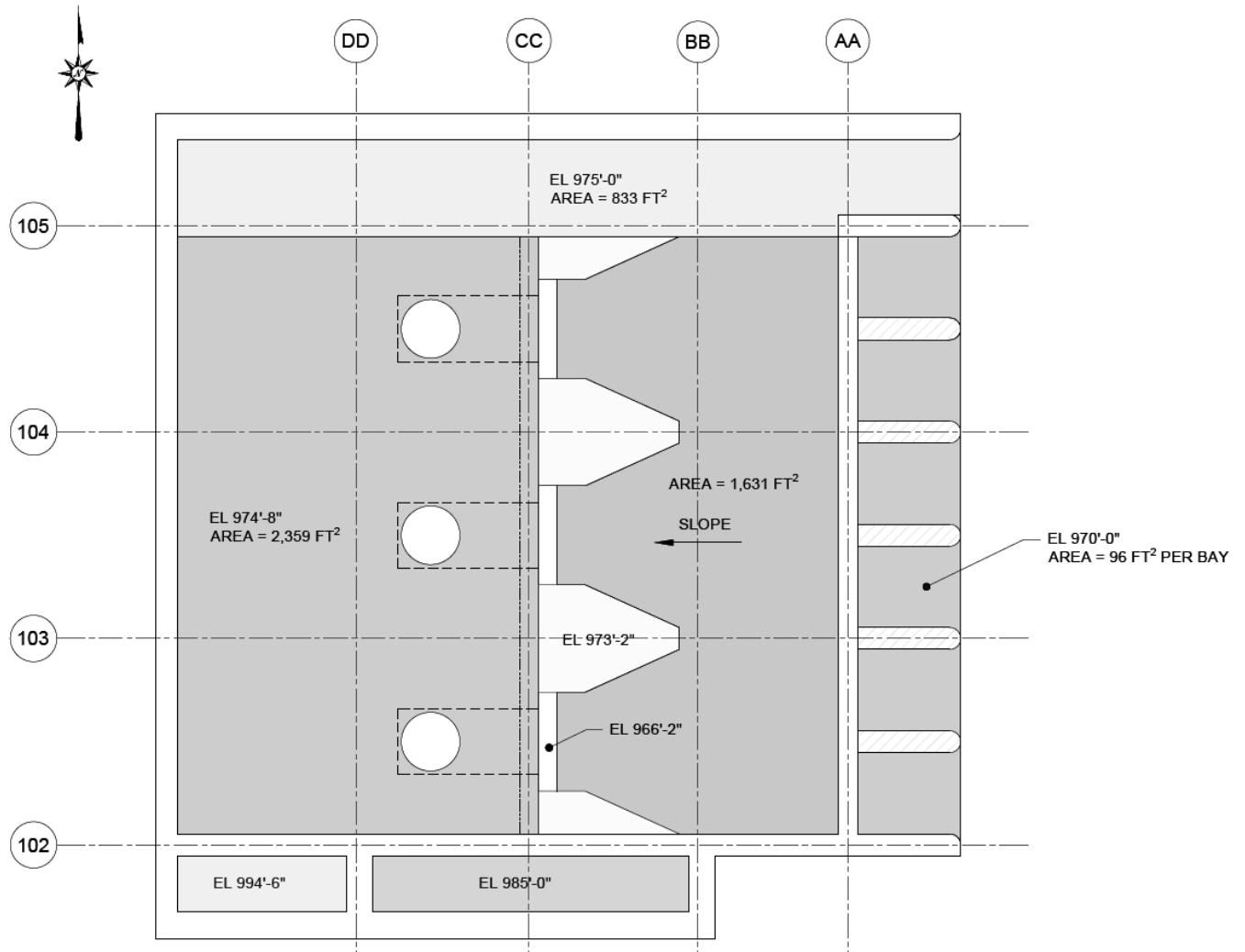


Figure 21 – Intake Structure Elevations

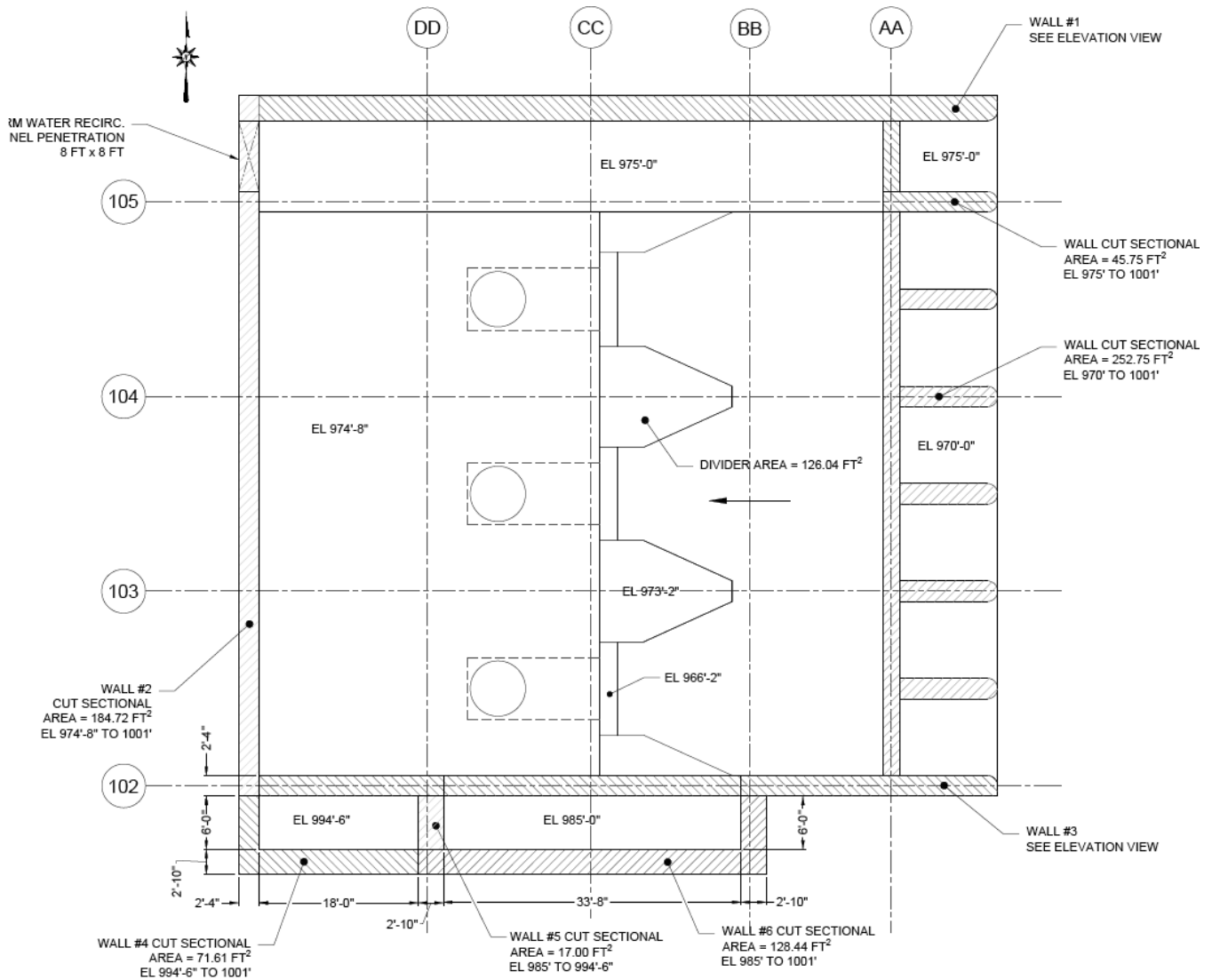


Figure 22 – Intake Structure Wall Cut Section Areas

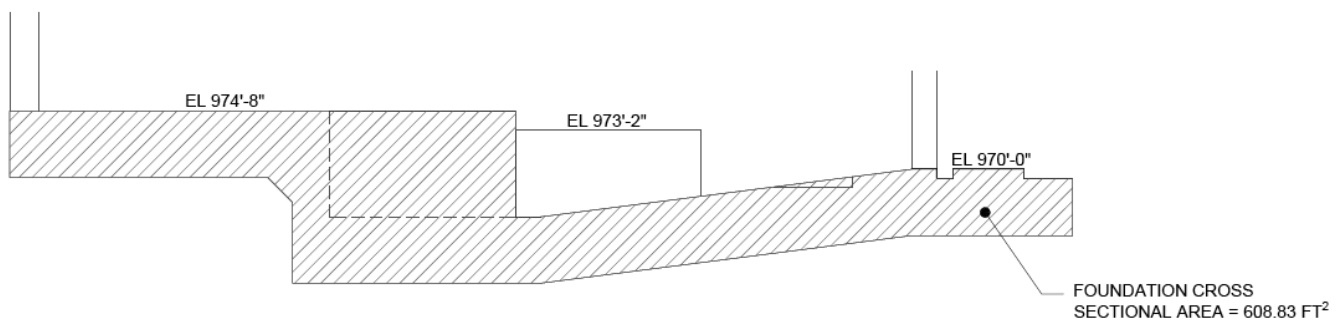


Figure 23 – Southern Portion of Intake Structure Fdn; Cut Section Looking North

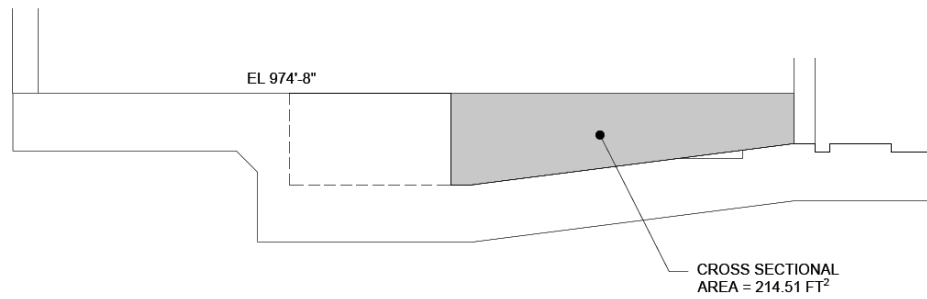


Figure 24 – Intake Structure Cut Section Looking North – Void Space

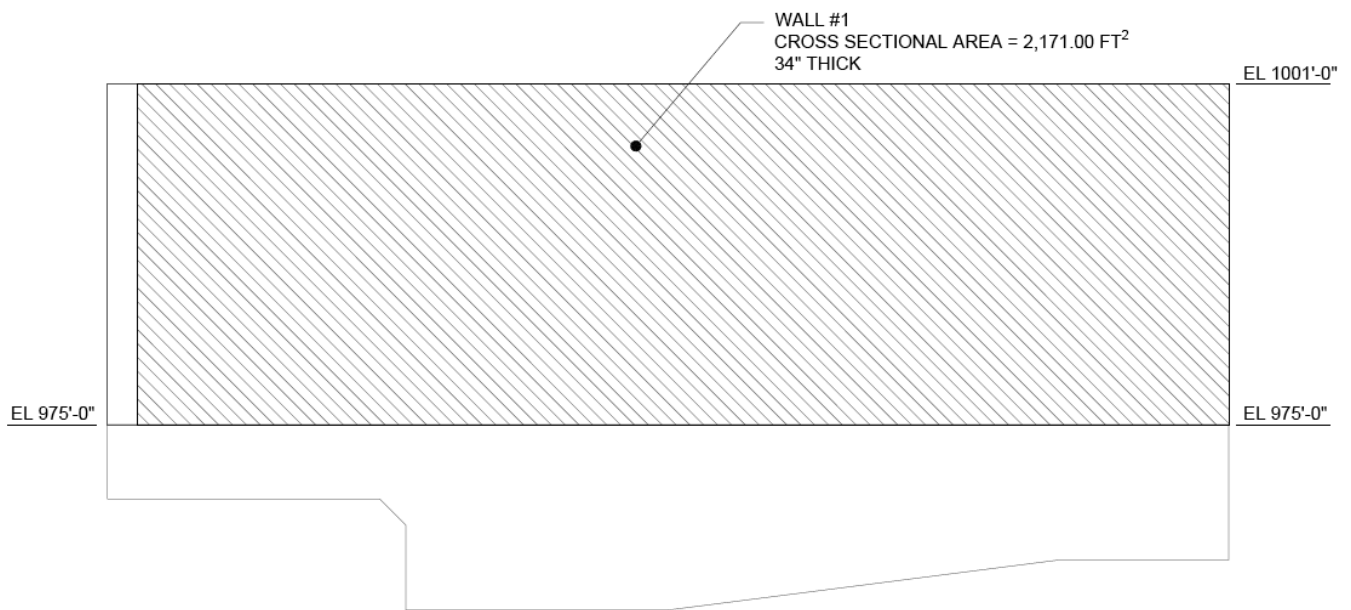


Figure 25 – Wall #1 Cross Sectional Area

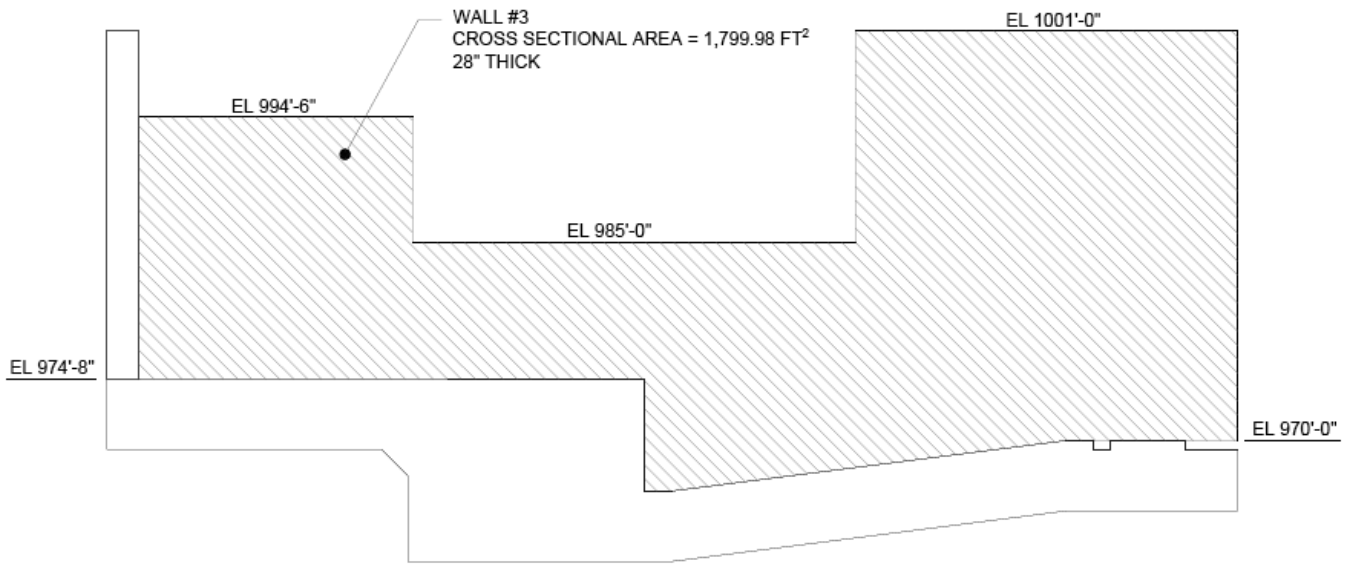


Figure 26 – Wall #3 Cross Sectional Area

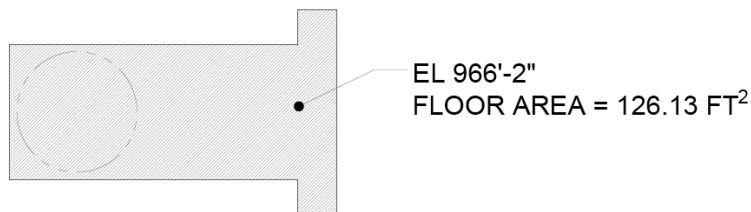


Figure 27 – Sump Pit Floor Area

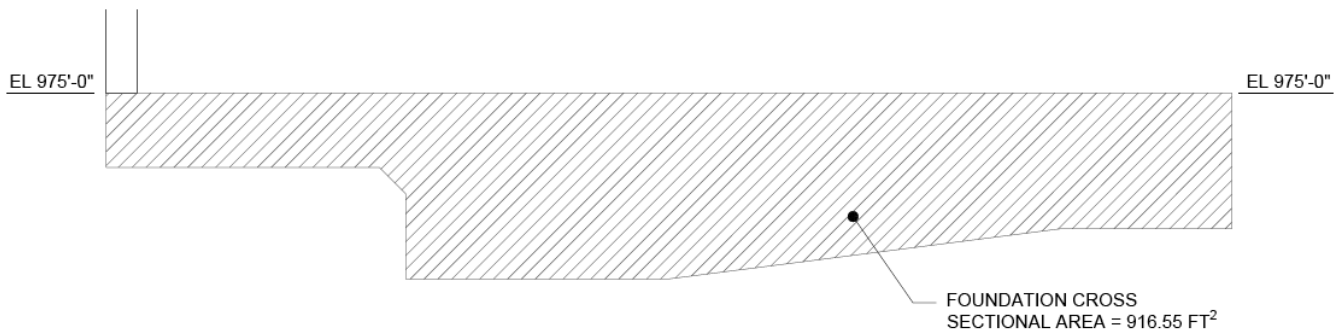


Figure 28 – Northern Portion of Intake Structure Fdn; Cut Section Looking North

6.6 Linear Footage Figures

The following figures demonstrate what walls were considered in the linear footage totals for each structure. Refer to the corresponding calculation section of the report for more details.

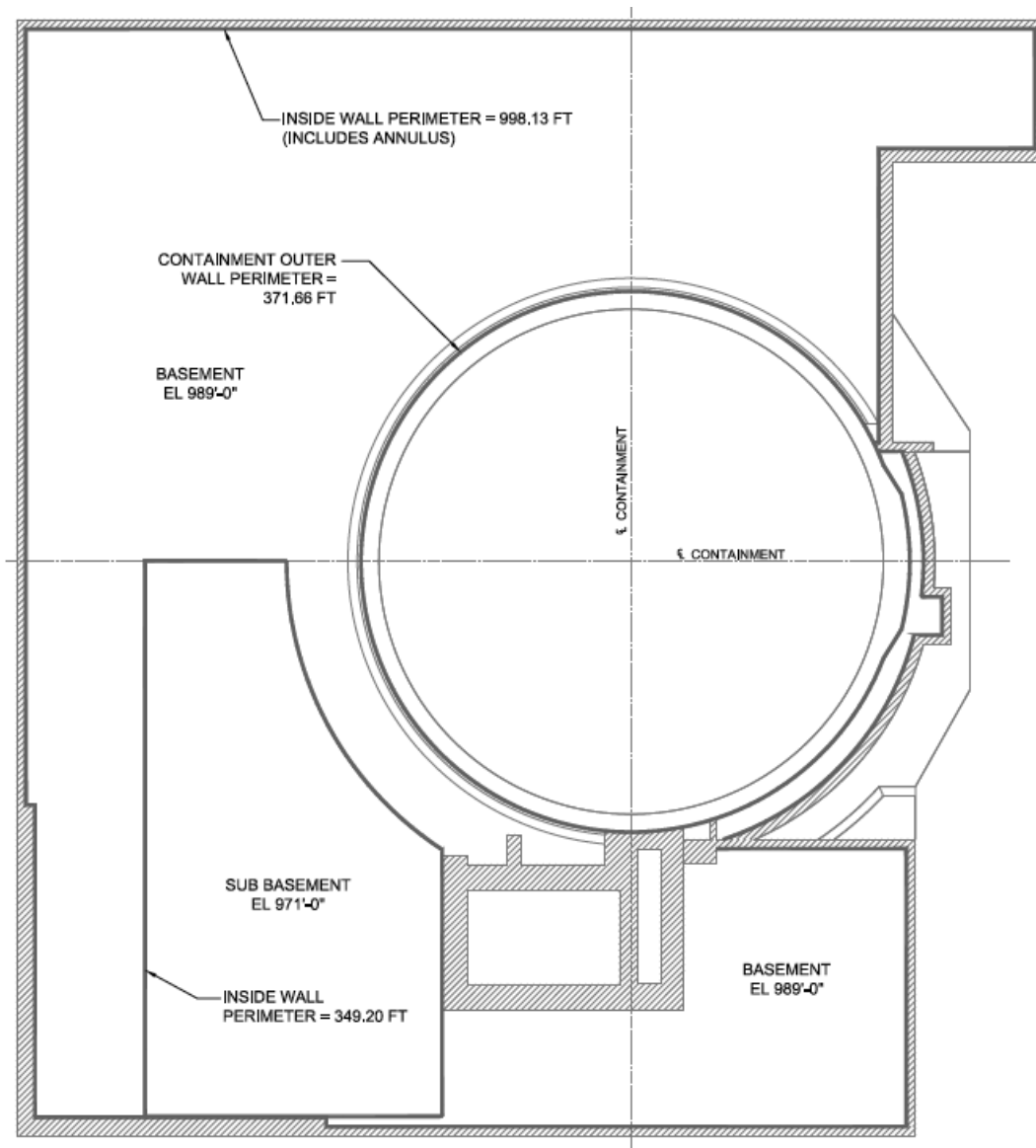


Figure 29 – Aux Building Linear Footage

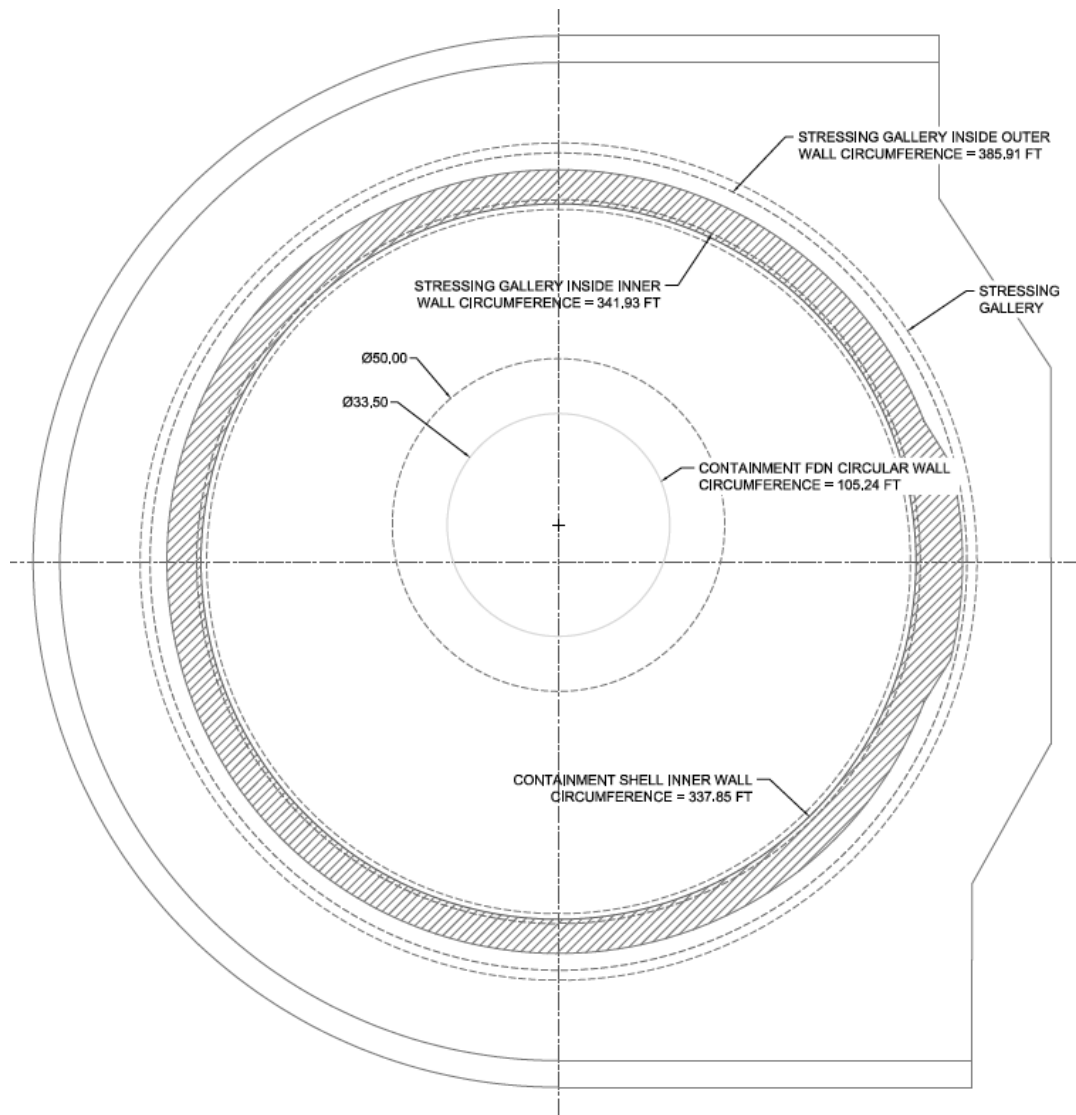


Figure 30 – Containment Linear Footage

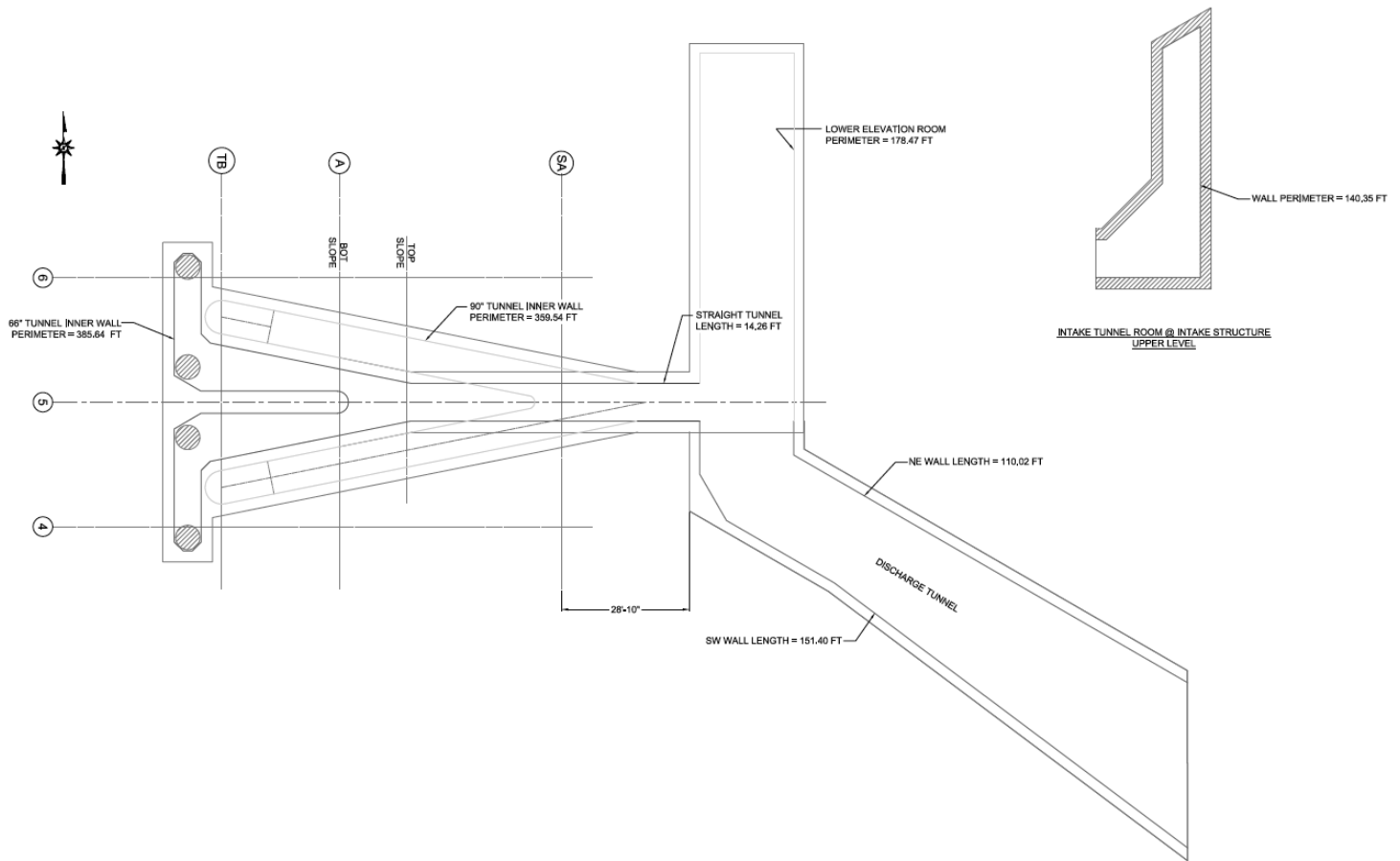


Figure 31 – Circ Water Tunnels Linear Footage

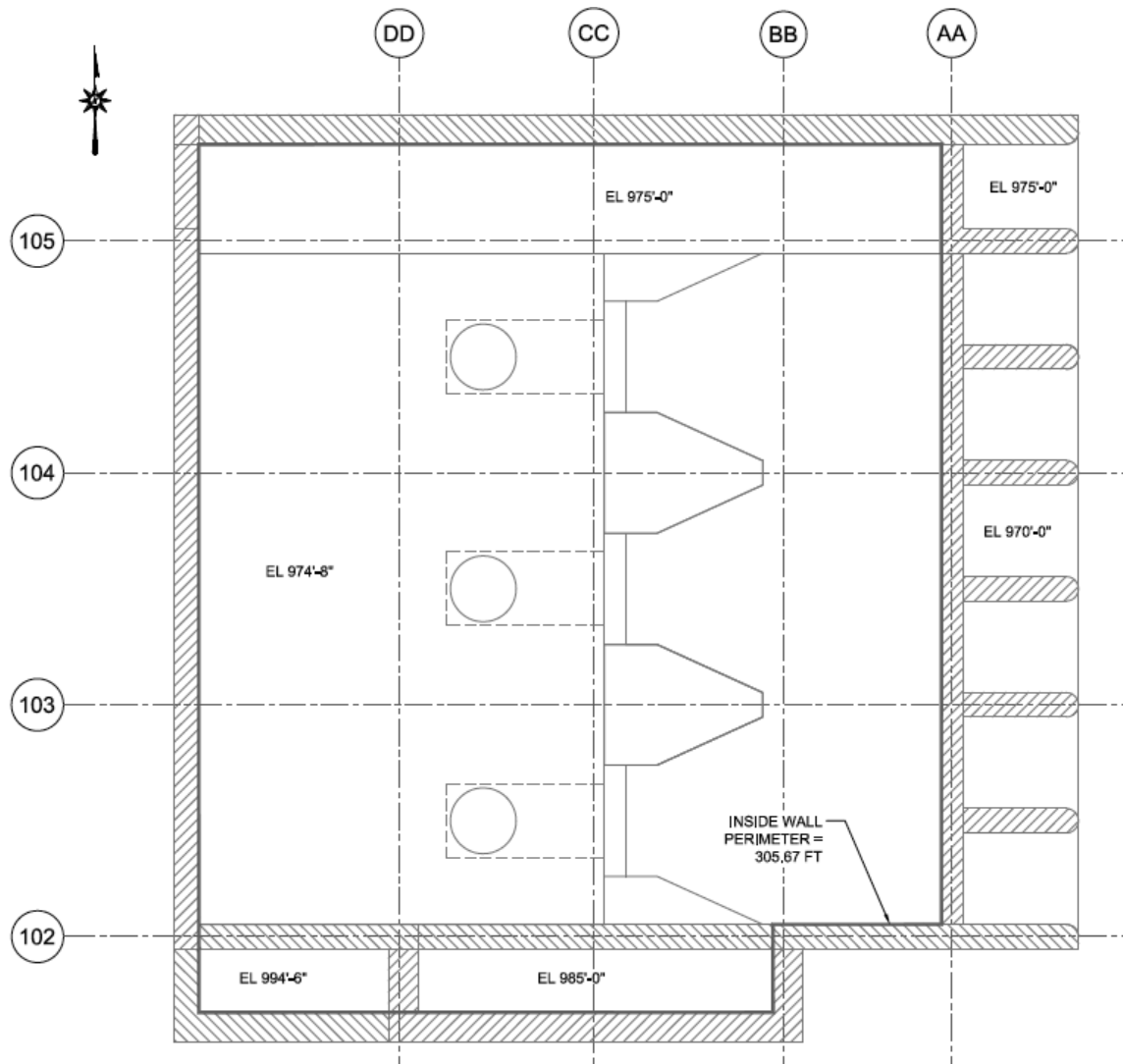


Figure 32 – Intake Structure Linear Footage